INSTRUCTION BOOK NO. 66M370 ISS NO.

INSTALLATION, OPERATION AND SERVICE

BRISTOL SERIES 760 STRIP-CHART DYNAMASTER PYROMETER

SERIAL NO. 66M370 CUST. ORDER NO. 57392

RECORDING
INDICATING
CONTROLLING
TELEMETERING
INSTRUMENTS

BRISTOL'S

THE BRISTOL COMPANY
WATERBURY 20, CONN.

PLACE THESE INSTRUCTIONS WITH THE MAN IN CHARGE OF YOUR INSTRUMENTS

I M P O R T A N T

1. Read these instructions NOW before installing instrument.

2. Keep these instructions permanently & accessibly filed for future reference.

3. Be sure to specify MODEL & SERIAL numbers when ordering parts, instructions, diagrams or data.

4. Ship instruments or parts for repair or exchange only to Bristol's main or branch factories—not to Sales Offices.

5. Be sure to—
   1. Identify your shipments with your exact return address & order number.
   2. Write nearest Bristol Factory or office giving your order number, directions & address for return shipment, full instructions for repair, etc.

6. Report damage to shipments at once to shipping company. The *customer assumes responsibility for collecting any claim for damages* from the shipping company, on all shipments made on a collect basis.

WHO WILL SERVICE YOUR BRISTOL INSTRUMENT?

Divided responsibility produces misunderstanding and inattention. We therefore urge that all Bristol instruments in your plant be assigned to the care of one responsible man. He will rapidly become so familiar with routine chart changing, inking, checking and adjusting necessary to keep instruments in good working order, as to require only a few minutes time per day. Bristol will be pleased to supply additional information or personal instruction to instrument service men.

INSTRUCTION BOOK NO. 66M370 ISSUE NO. 1

INSTALLATION, OPERATION AND SERVICE

BRISTOL SERIES 760 STRIP-CHART DYNAMASTER PYROMETER

FOR SERIAL NO. 66M370 CUST. ORDER NO. 57392

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	WIRING DIAGRAMS	
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	MEAS.	021171
	AUX.	021180
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INSTRUCTION NO. P12600

(Replaces issue of 10/63)

INSTALLATION, OPERATION AND SERVICE

BRISTOL® MODEL 760 STRIP-CHART DYNAMASTER.

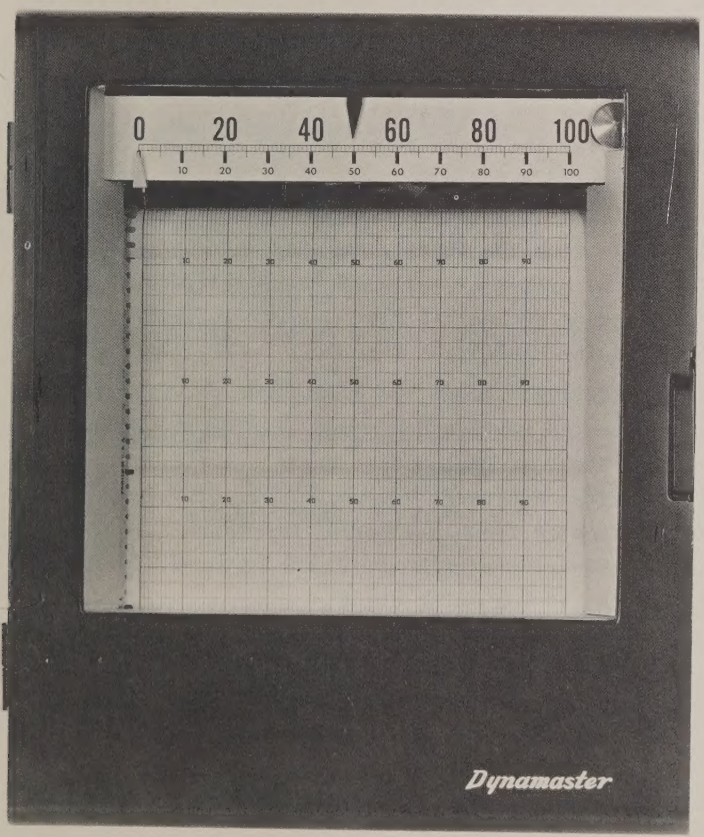

FIGURE 1. FRONT VIEW SERIES 760 DYNAMASTER

THE BRISTOL COMPANY WATERBURY, CONN. 96720

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PART I GENERAL

A. Description

The Dynamaster potentiometer is used with any millivoltage input such as that from thermocouples, photoelectric cells, shunts, magnetos, pH amplifiers, etc.

The Dynamaster d-c bridge is used with a very low range resistance type measuring element, such as resistance thermometer bulbs, strain gauges, etc.

The Dynamaster a-c bridge is used with any resistance type of measuring element, such as resistance thermometer bulbs, conductivity cell, etc. The a-c bridge should not be used where a-c pickup is a problem.

Both single-pen and two-pen recorders are available.

The major components of the instrument are:

1. The bridge circuit
2. The amplifier
3. The balancing motor
4. The recording system

B. Principle of Operation

1. The Dynamaster Potentiometer. A potentiometer measures an emf of unknown value by comparing it with a known emf. In the Dynamaster potentiometer, the millivoltage input from the sensing element is connected in series with the potentiometer circuit and Syncroverter® switch. A standard voltage, supplied by a Zener diode reference voltage source in the potentiometer circuit, is automatically adjusted to balance any change in the millivoltage input. Any change in the measuring-element voltage creates a d-c voltage unbalance in the potentiometer circuit. This d-c voltage unbalance is converted to an a-c voltage unbalance by the Syncroverter switch. The Syncroverter a-c unbalance output voltage is then increased by the amplifier to a power level sufficient to operate the balancing motor. The balancing motor adjusts the sliding contact on the slidewire to restore electrical balance in the potentiometer circuit and simultaneously moves the pen and pointer to record and indicate, on the chart or scale, the value of the variable being measured.

The balancing action starts with the slightest change in the output voltage of the sensing element. Thus, recording and indicating of the measured quantity are practically instantaneous.

When balance has been restored, the entire potentiometer remains at rest until another change in the measured variable occurs.

2. The Dynamaster D-C Bridge. In a D-C bridge, the measuring element forms one leg of the d-c bridge. A d-c power pack supplies 7 to 9 volts d-c to the bridge circuit. When the resistance of the measuring element changes, current flows in the bridge and a d-c voltage unbalance is created in the bridge circuit. This d-c voltage unbalance is converted to an a-c voltage unbalance by the Syncroverter switch. The Syncroverter a-c unbalance output voltage is then increased by the amplifier to a power level sufficient to operate the balancing motor. The balancing motor adjusts the sliding contact on the slidewire to restore electrical balance in the bridge circuit and simultaneously moves the pen and pointer to record and indicate, on the chart or scale, the value of the variable being measured.

This balancing action starts with the slightest change in the resistance of the measuring element. Thus, recording and indicating of the measured variable is practically instantaneous.

When balance has been restored, the entire bridge remains at rest until another change in the measured variable occurs.

3. The Dynamaster A-C Bridge. The a-c bridge is the same as the d-c bridge except for two items. In the a-c bridge, a bridge transformer is used instead of a d-c power pack and a shorting plug is used instead of the Syncroverter switch.

In an a-c bridge, the measuring element forms one leg of the a-c bridge. A bridge transformer supplies a-c to the bridge circuit. When the resistance of the measuring element changes, current flows in the bridge and a voltage unbalance (error signal) is created. This error signal is fed into the amplifier and amplified to a power level sufficient to operate the balancing motor. The balancing motor adjusts the sliding contact on the slidewire to restore electrical balance in the bridge circuit and simultaneously moves the pen and pointer to record and indicate on the chart or scale, the value of the variable being measured.

This balancing action starts immediately with the slightest change in the resistance of the measuring element. Thus, recording and indicating of the measured quantity are practically instantaneous.

When balance has been restored, the entire bridge remains at rest until another change in the measured variable occurs.

PART II INSTALLATION

A. Unpacking the Instrument

Do not throw away the packing material until you have found the (4) mounting bolts and other accessories, such as ink, charts, spare parts, etc.

B. Locating and Mounting the Instrument

The Series 760 Dynamaster is designed for flush panel mounting only. Although the instrument is exceptionally free from the effects of dust, dirt, vibration, corrosive fumes and extremes of temperature, it should be located as remotely as possible from such unfavorable conditions. The location should also be convenient for service and general utility.

The case is mounted by means of 4 toggle bolts. The panel cutout should be 10 7/16" (+1/16 -0)" wide by 12 11/16" (+1/16 -0)" high. Horizontal clearance between centerlines of instruments should be no less than 13". Vertical clearance between centerlines of instruments should be no less than 15 1/4".

To facilitate mounting the instrument, it is suggested that the chassis be withdrawn from the case. First, open door and remove door by lifting door upward. Next, disconnect terminal straps from back of case (it is not necessary to disconnect cables from terminal blocks). This will disconnect all wiring between chassis and case.

Next, using levers, items 1 and 2, fig. 4, pull chassis out as far as the first stop in guide channels. The levers must first be lifted upward to release chassis from case. Using both hands (one on each side of chassis), depress detent clips (item 6, fig. 5 and item 2, fig. 8) and slide chassis out of case. Next, insert the 4 bolts in the 4 corner holes of the case and screw the toggles on each of the bolts. Insert case in panel cutout and tighten bolts until case is held rigidly to panel. Replace chassis and refasten terminal straps to original position in back of case.

Note: Be sure to replace terminal straps with the coil cord clamp at the top of case as illustrated in Figure 3.

C. External Wiring

Before connecting any wiring to the Dynamaster, check the voltage and frequency listed on the nameplate of the instrument. To connect the Dynamaster to a voltage greater than 120 volts, a suitable stepdown transformer must be used. All wiring connections are made on the terminal blocks mounted inside on the back of the case. The terminals are readily accessible by first removing the back cover plate.

The case is provided with one 3/4" conduit hole and one 1/2" conduit hole on each side of

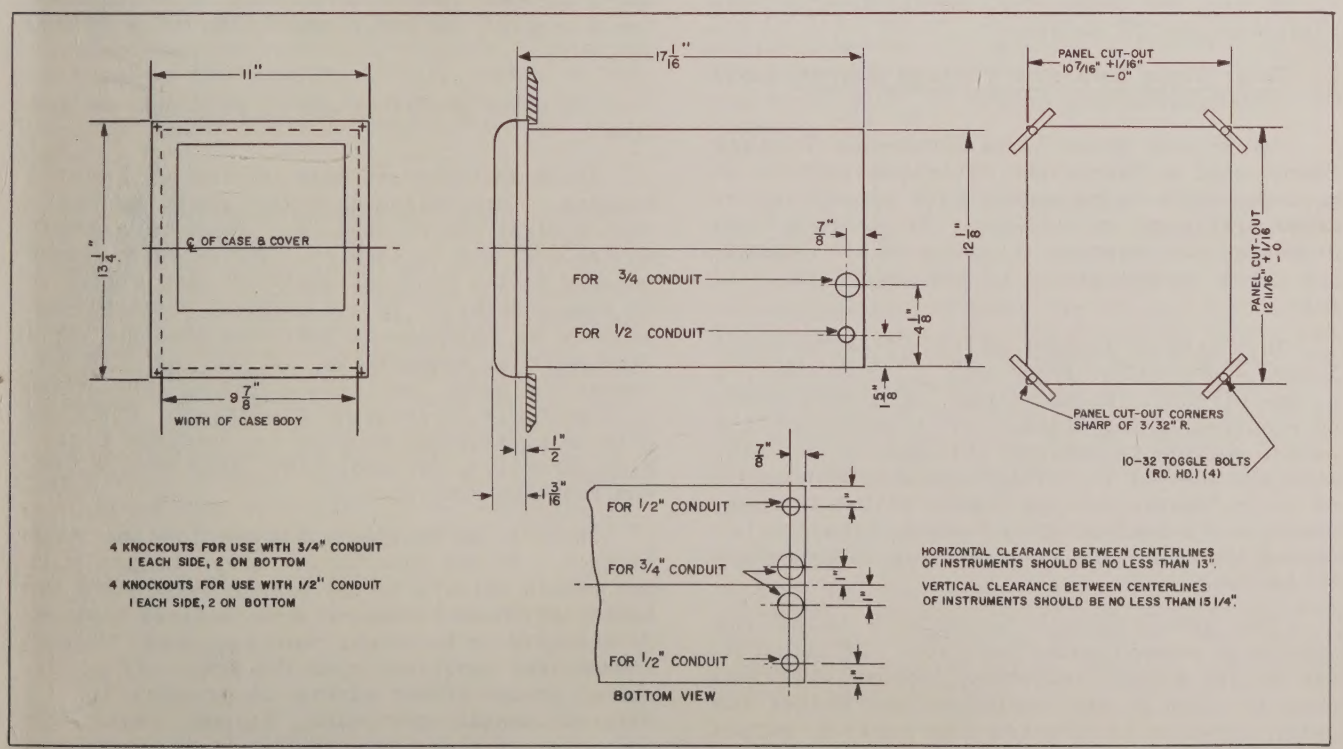
11"
13 1/4"
℄ OF CASE & COVER
9 7/8"
WIDTH OF CASE BODY
17 1/16"
7/8"
12 1/8"
FOR 3/4 CONDUIT
FOR 1/2 CONDUIT
4 1/8"
1/2"
1/2"
1 3/16"
7/8"
FOR 1/2" CONDUIT
FOR 3/4" CONDUIT
FOR 1/2" CONDUIT
BOTTOM VIEW
4 KNOCKOUTS FOR USE WITH 3/4" CONDUIT 1 EACH SIDE, 2 ON BOTTOM
4 KNOCKOUTS FOR USE WITH 1/2" CONDUIT 1 EACH SIDE, 2 ON BOTTOM
PANEL CUT-OUT 10 7/16" +1/16" -0"
PANEL CUT-OUT 12 11/16" +1/16" -0
PANEL CUT-OUT CORNERS SHARP OF 3/32" R.
10-32 TOGGLE BOLTS (RD. HD.) (4)
HORIZONTAL CLEARANCE BETWEEN CENTERLINES OF INSTRUMENTS SHOULD BE NO LESS THAN 13".
VERTICAL CLEARANCE BETWEEN CENTERLINES OF INSTRUMENTS SHOULD BE NO LESS THAN 15 1/4".

FIGURE 2. MOUNTING DIMENSION DRAWING.

the case and two 3/4" conduit holes and two 1/2" conduit holes on the bottom of the case to accomodate standard conduit fittings. Conduit should be used whenever possible to bring all electrical circuits into the case. If conduit is not used, the rubber grommets supplied with the instrument should be used to keep the holes as tight as possible.

The wiring diagrams for your particular Dynamaster are provided separately.

When connecting the power line to the instrument, make sure that the grounded side of the line is connected to terminal marked L2.

A good ground **must be** connected to the terminal marked GND.

Note: Do not install measuring circuit wiring in the same conduit with higher voltage lines such as 120V., 60 cy. supply.

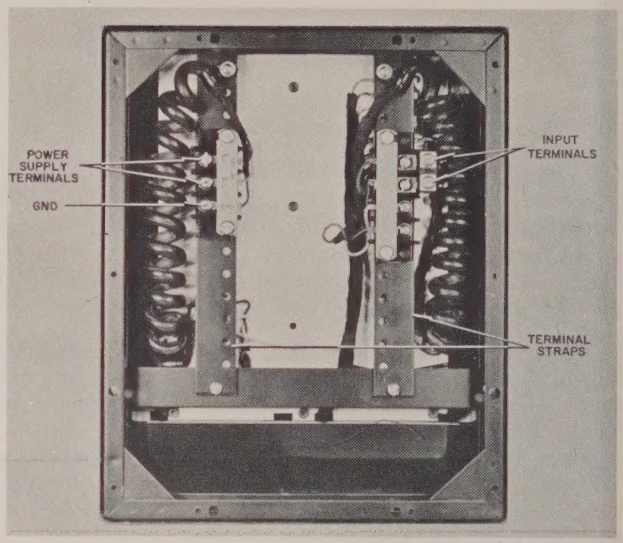

FIGURE 3. REAR VIEW OF CASE WITH BACK COVER REMOVED.

PART III OPERATION

A. Starting the Dynamaster

To start the Dynamaster after it has been completely and correctly wired, simply turn on the instrument "ON-OFF" switch located on the right hand side of the chassis.

B. Stopping the Dynamaster

To stop the Dynamaster, merely turn off the instrument ON-OFF switch.

C. Zener Diode Reference Voltage Source (used on Potentiometers only).

The Bristol Zener Diode Reference Voltage Source used on Dynamaster Potentiometers is an accurate d-c voltage source with a high degree of stability and reliability. It utilizes Zener Diodes as the reference elements in the preregulating and output stages of the regulating circuit.

This unit is factory adjusted to produce 1.0190 $\pm$.001 volts across the potentiometer bridge circuit. No additional adjustment should be required in the field. If a check of the output voltage is desired, it should be done with the load of the bridge circuit disconnected at the reference voltage source output terminal block, and a load of 339.67 ohms substituted across the terminals as equivalent to the proper bridge load.

The check should be made by balancing against a potentiometer test set. If the voltage is not within tolerance, remove the black snap-in plug in the enclosure and adjust the potentiometer to produce the correct output voltage. Replace snap-in plug after any adjustment.

D. Amplifier Gain Adjustment

1. On single- and two-pen Recorders. The only time the amplifier gain adjustment need be checked is after changing tubes or doing other service work on the amplifier and about once every 3 to 6 months thereafter. The reason for the periodic check is because the vacuum tubes age with use. While this check is being made, the measured variable should be at a steady value.

To check amplifier gain, proceed as follows:

Allow amplifier to warm up for at least 2 minutes. Turn balancing motor shaft manually to the right and release it. Then turn shaft to the left and release it. Pen should return quickly to its original position each time. If it does not return to its original position completely and quickly, it indicates that the amplifier gain (or sensitivity) is too low. To increase the gain, turn gain adjusting screw (item 2, fig. 5) in a clockwise direction. When the gain adjustment has reached its maximum clockwise direction, the amplifier lacks sensitivity and requires new tubes.

There is an optimum position for the gain control. If the gain is too low, the pen will not return quickly to its proper value when the balancing motor is manually shifted off balance. If the gain is too high, the pen may "hunt" (mechanical oscillation of the pen). If an abnormal amount of a-c pickup is present in the external measuring circuit, it may cause the motor to act sluggishly even with the gain set high. The sensitivity goes through a peak and

appears to reduce as the gain is advanced. The calibration of the instrument may also shift as the gain is increased. The condition may be improved by finding the optimum setting of the gain control but the correct solution is to eliminate the a-c pickup at its source.

2. On Multiple-point Recorders. The gain adjustment on multiple-point recorders is made in the same manner as on single-pen recorders except that the motor on the multiple-switching mechanism must be stopped during this adjustment. A switch, (see fig. 12) mounted on the mechanism, is provided for this purpose.

E. Installing the Chart

1. On single- and two-pen Recorders. Open door of recorder. Pull chassis out about 6 inches. Chassis may be pulled out by first lifting up on the two release levers (item 1 & 2, fig. 4). Next, push down on the two levers (items 3 & 4, fig. 4) and chart drive assembly will drop forward. If the chart drive is to be left in the forward position, be sure to remove ink from the capillary system. Place feed roll in trough with pressure plate on top of chart roll. Unroll portion of chart and attach end of chart to cardboard core with tape. Place spindle hub with bearing pin in left-hand end of chart core and the spindle with the hex socket in the right-hand end of the chart core. Unroll sufficient chart to permit passing rewind roll under and around in back of chart drive assembly. Insert right-hand end of chart rewind spindle in hex shaft of rewind drive and press inward (from left to right) to permit bearing pin in left hand spindle to slip into slot in plate and hole of spring plate. Swing chart assembly back to its original position. Chart may be made taut by pulling upward on rear portion of spring (item 2, fig. 8). Be sure to properly locate slots in chart over the drive pins.

2. On multiple-point Recorders. Included with the accessories for multiple-point recorders are two spindle hubs which are to be installed by the user in each end of the chart roll before the chart roll is installed in the instrument. The purpose of the hubs is to prevent excessive end play as the chart is being unwound. When inserting the hubs, it is advisable to insert the first hub in the end with the chart perforations and then tap this end on a flat surface to make sure the chart is squared up. After the hubs have been inserted, the chart may be installed as per paragraph 1 above.

F. Inking System

For single- and two-pen Recorders. The Series 760 Dynamasters are provided with a plastic ink bottle located on a pull-out bracket on the right side of the chassis. The ink bottle is connected to the recording pen by capillary tubing.

1. Filling Ink Bottle. Pull chassis out about 6 inches. Pull ink bottle out by means of wire ring (item 1, fig. 8) on its mounting bracket. Fill bottle thru hole in top as far as line marked on bottle (see Fig. 7).

2. Starting Ink Flow. Place finger over filling hole in ink bottle and squeeze bottle until ink flows thru capillary to pen and then release finger from filling hole. Be sure to push ink bottle back before pushing chassis back into the case.

G. Checking Mechanical Stop

All Series 760 Dynamasters are provided with a mechanical stop (item 2, fig. 7) set so that the pen is mechanically stopped at a point .025" below the calibrated zero. All charts are printed with a dash line .025" below the calibrated zero; the calibrated zero being the low end calibration line on the chart.

To check mechanical stop, turn off instrument power switch. Rotate balancing motor shaft in a direction to drive pen downscale as far as it will go. If pen is not on the dash line, loosen the two screws (item 3, fig. 7) and shift stop bracket as required. Tighten screws after adjustment.

H. Checking Electrical Zero

1. Potentiometer Type Instruments. Potentiometer type instruments may be checked with a precision instrument such as a Bristol Model 98A Test Set. See separate instructions for proper use of the test set for checking pyrometers and millivoltmeters. If a point check is made and the recording pen is found to be in error, it may be adjusted by means of pen zero adjustment (item 1, fig. 7).

2. Bridge Type Instruments. A bridge type instrument may be checked with a precision test resistor. This precision resistor permits a rapid calibration check at one point of the instrument scale. To make the check, disconnect the primary element at the terminal block and connect the checking resistor in its place. The instrument should correspond to that specified on the checking resistor. If instrument does not record proper value, adjust pen zero adjustment (item 1, fig. 7) until it does.

The Bristol Company manufactures very accurate test resistance spools. Spools may be ordered for any value to fit calibration of instrument. Ordinary variations in room temperature do not affect their accuracy. When ordering spools, specify serial number, curve and check points desired.

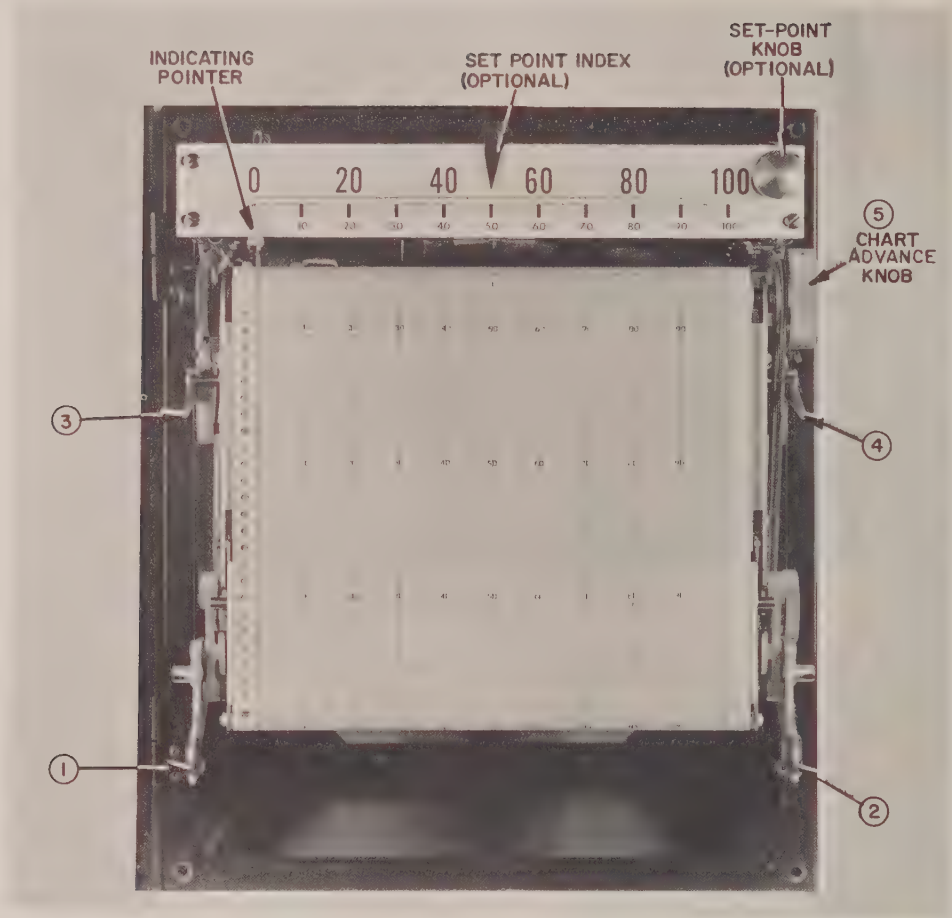

FIGURE 4. FRONT VIEW WITH DOOR OPEN.

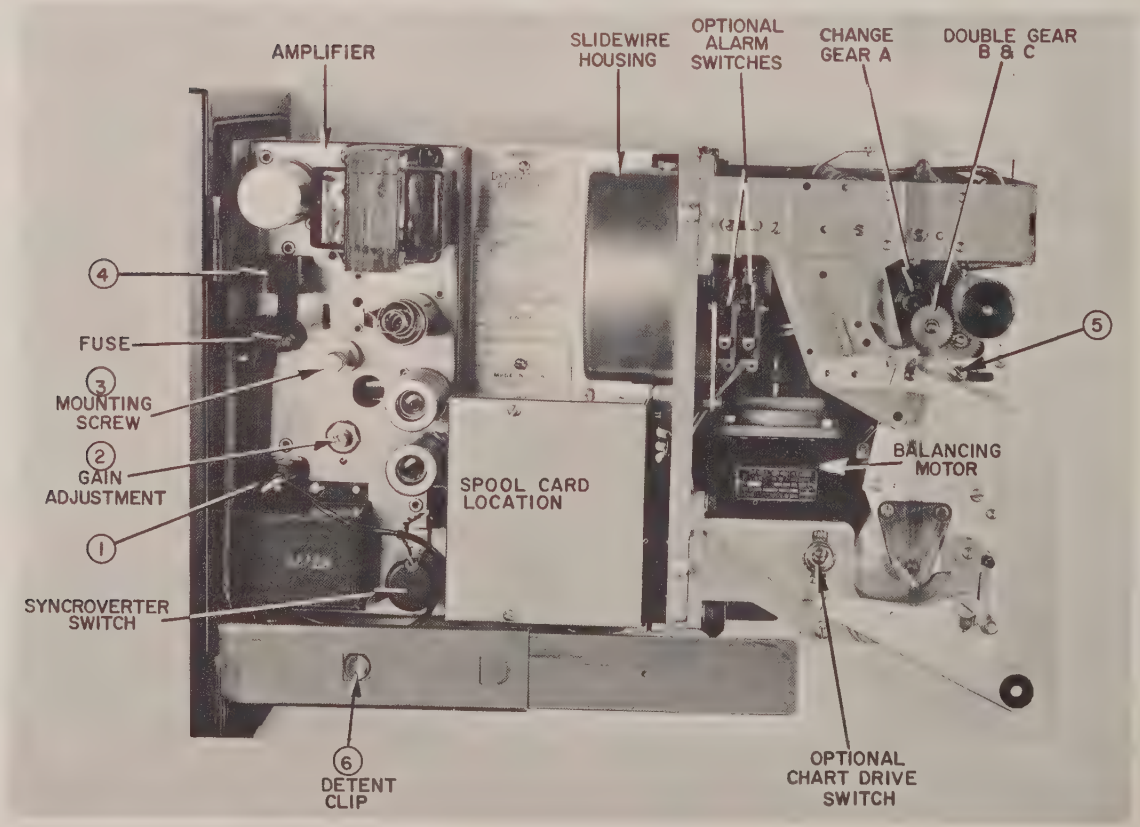

FIGURE 5. LEFT SIDE OF CHASSIS.

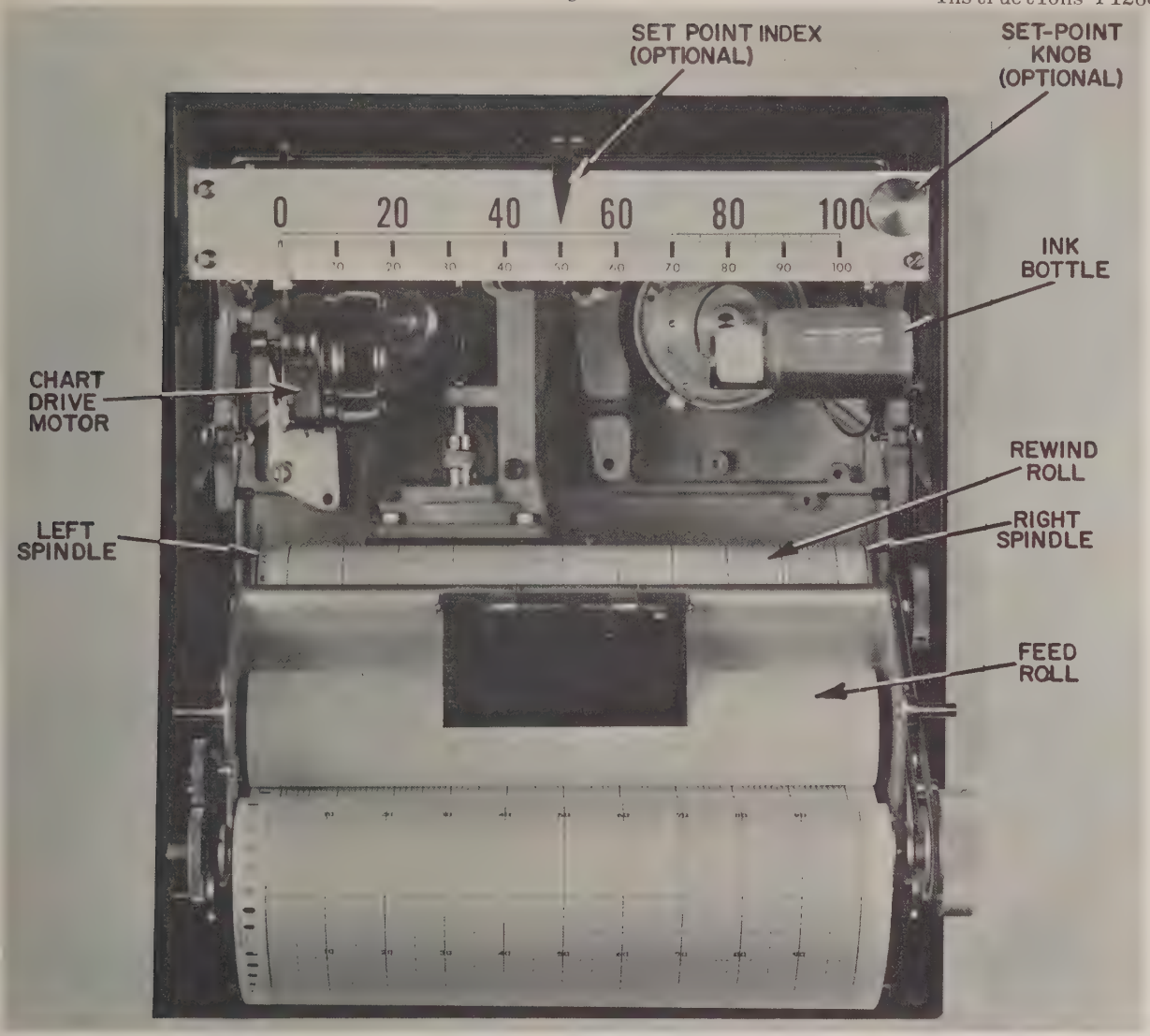

FIGURE 6. FRONT VIEW OF CHASSIS WITH CHART DRIVE DROPPED DOWN.

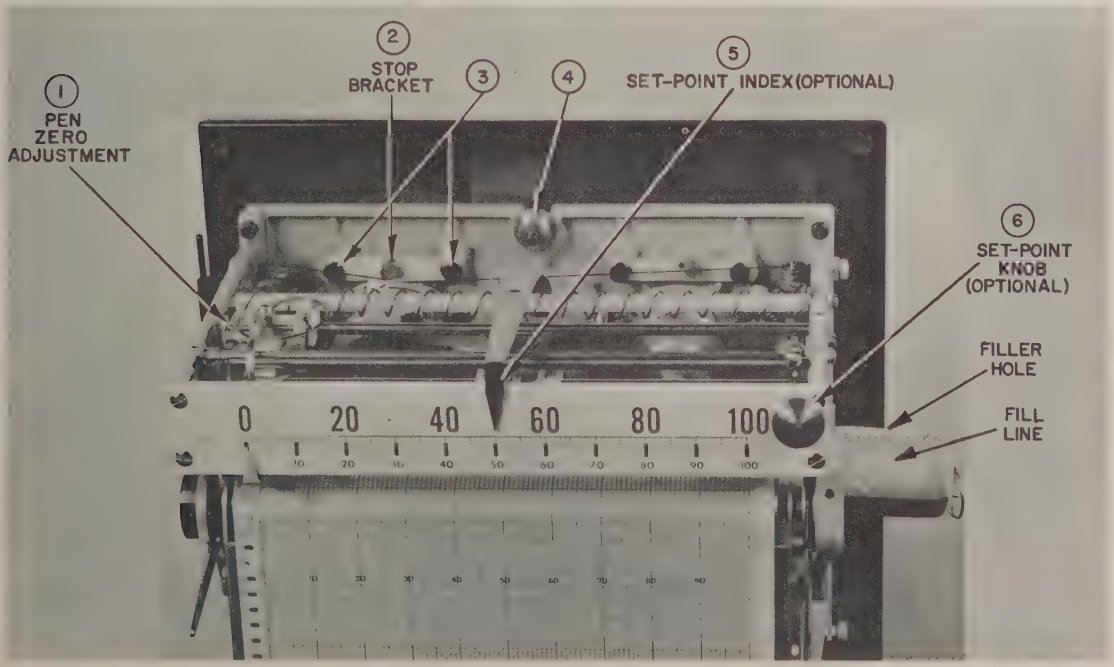

FIGURE 7. FRONT VIEW SHOWING INK BOTTLE PULLED OUT.

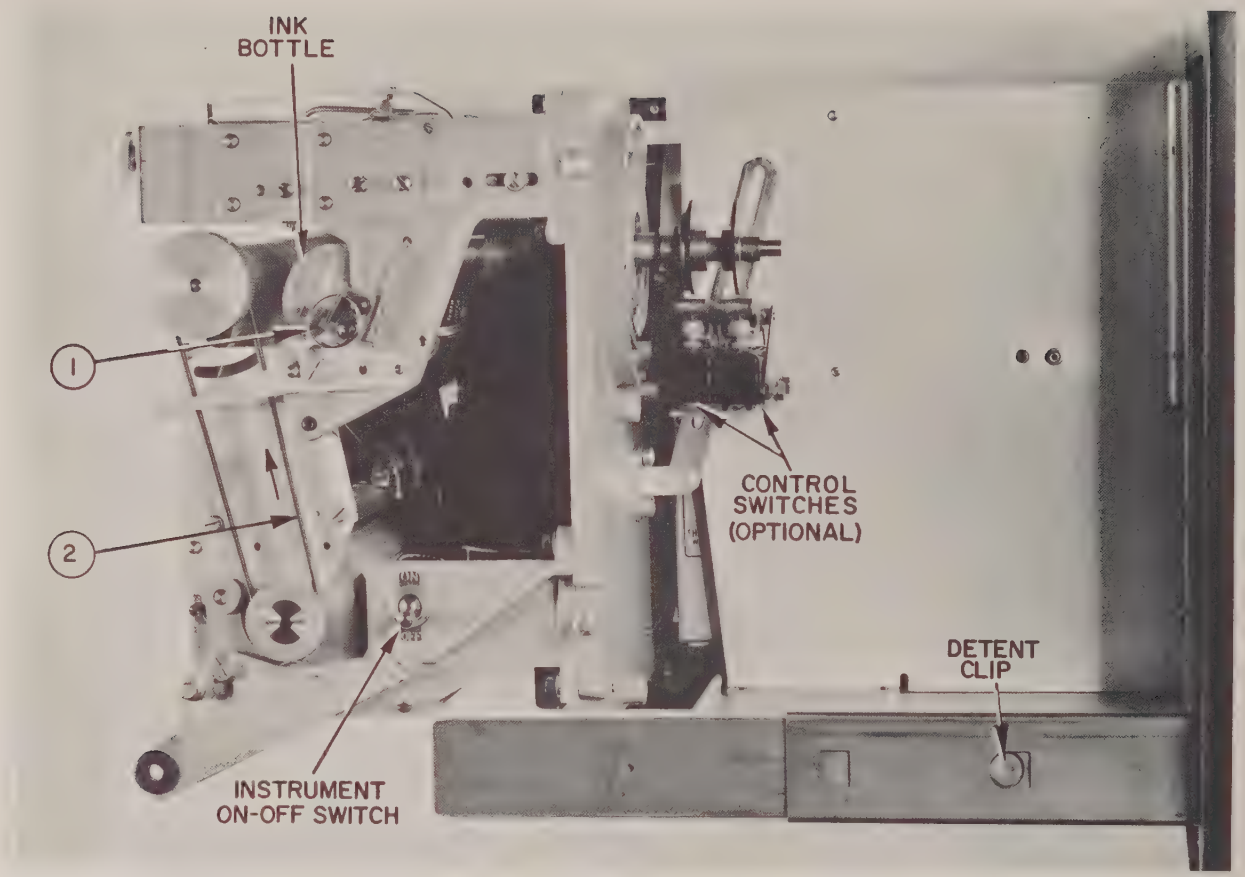

FIGURE 8. RIGHT SIDE OF CHASSIS.

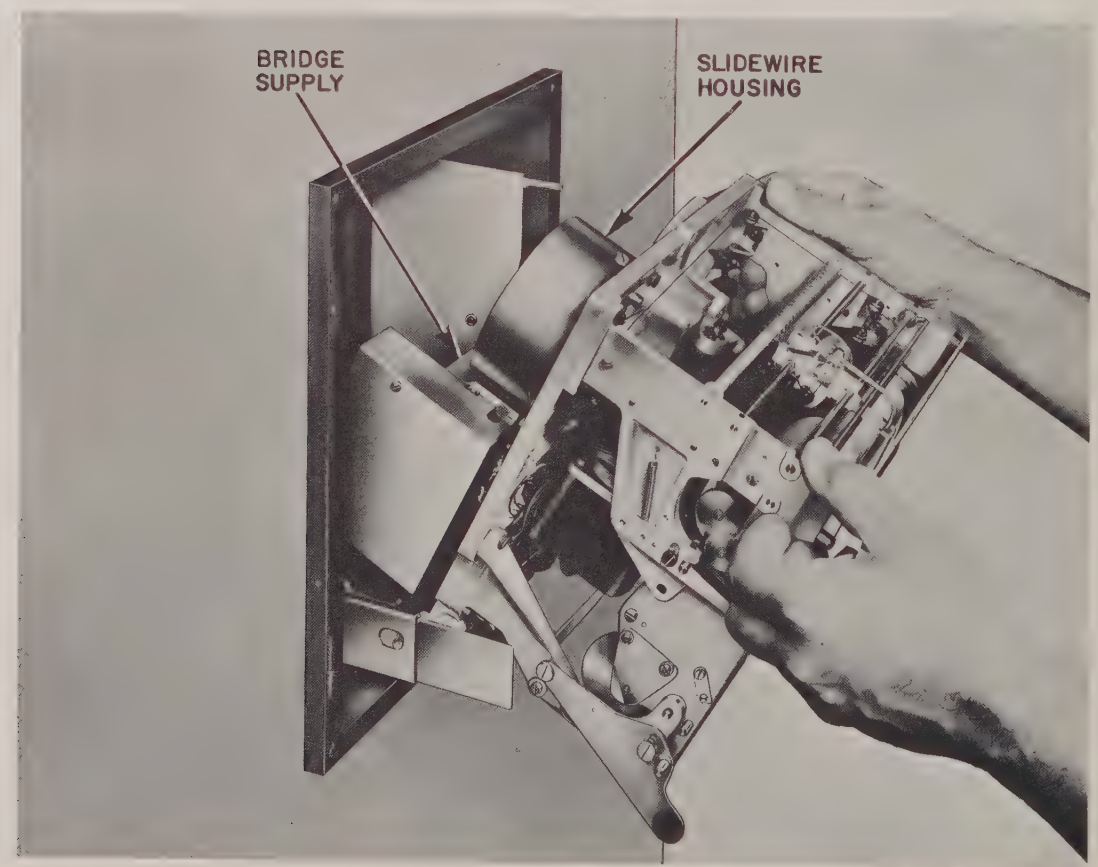

FIGURE 9. VIEW SHOWING HINGED FRAME SWUNG DOWN.

PART IV SERVICE

A. Suggested Service Equipment

1. Stock of Replacement Parts. It is suggested that the following replacement parts be kept in stock. The vacuum tubes listed below are standard types and are available at any radio supply store:

TYPE 6EU7 voltage amplifier tube

TYPE 6BQ5 power amplifier tube

Plug-in-type Electrolytic Filter Capacitor with octal base (10-10-10 mfd. 450 volt)

Note: Electrolytic capacitors deteriorate in storage. Their shelf life should not be over 18 months. Replacement electrolytic capacitors can be kept in usable condition indefinitely by placing them in service in the Dynamaster for an hour or two every six months.

FUSES for amplifier (1/8 ampere Littlefuse Slo-blo).

AMPLIFIER. Where several Dynamasters are in use or where continuous instrument performance is of critical importance, it is recommended that spare replacement amplifiers be kept in stock.

2. Test Equipment

A signal generator, such as Bristol's Dynaprobe Part No. C1038, is highly recommended because it provides a quick means for isolating trouble in the detection circuit of the Dynamaster without having to remove the Dynamaster from service or disconnecting the input circuit or the power to the instrument.

The Bristol Dynaprobe test unit is a compact signal generator designed for use with the Bristol Dynamaster.

The Dynaprobe consists of a covered metal box with a 2-foot cable with **test probes** or a test plug and two additional extensions, one with lugs at the end and the other with a female plug. The box has a toggle switch to provide either a 10 millivolt d-c signal or a 30 millivolt a-c signal as required. The output signal is neither regulated or calibrated. The back of the box is fitted with two prongs and two spring type connections to permit plugging the unit into the power terminal block of the Dynamaster.

The Dynaprobe is also equipped with a receptacle to provide 120 volt a.c. for a soldering iron.

An a-c voltmeter or test lamp is required to perform the power-supply check.

An **ohmmeter** is convenient when checking the continuity of the measuring system.

On potentiometer-type instruments, a **potentiometric test set** is required (one with ranges 0 to 150 millivolts and 1.019 volts).

On bridge-type instruments, a set of **test resistance spools** is handy for checking resistance measuring instruments. The Bristol Company manufactures very accurate test resistance spools. Spools may be ordered by the set or singly for any value to fit calibration of instrument. Ordinary variations in room temperature do not affect their accuracy. When ordering spools, specify serial number, curve and check point desired.

B. Systematic Trouble-shooting Procedure

Should the Dynamaster fail in any way, it is first necessary to determine which part is faulty. The following systematic procedure is suggested in order that repairs may be accomplished with a minimum of lost time and expense.

1. Power-supply Check. Using a 150-volt range a-c voltmeter (or test lamp), check for line voltage across instrument power terminals L1 and L2 on back of case, back of chassis and front frame of chassis.

2. Balancing Motor Check

Caution: Always be sure to turn power switch off before shifting the two control winding wires because of the high voltage across terminals M1 and M2.

Turn off instrument power switch. Remove the red and blue control-winding wires from terminals M1 and M2 and connect them across terminals L1 and L2. Remove black motor lead from L1 and wire a 1-microfarad capacitor in series with it and reconnect to L1. Turn on power switch. The motor should move the pen up or downscale (depending upon phase). Next, turn off power switch and reverse these wires from the control winding. The balancing motor should move the pen in the opposite direction. If the balancing motor fails to move the pen up or downscale with the above test, it could mean that one of the following conditions exist.

1. No power to balancing motor
2. Balancing motor defective
3. Mechanical failure between balancing motor pinion, drive gear and recording pen.

Note: When test has been completed, be sure to return red and blue wires to their original positions (see power circuit wiring diagram) and remove capacitor in series with black wire.

3. Checking Amplifiers

a. With Syncroverter Switch (used on d-c instruments)

With the external power supply switch off, plug Dynaprobe into power supply terminal block on back of instrument case. Set Dynaprobe toggle switch in d-c position. Using extension with polarized female plug, plug extension into input terminals of amplifier. Turn on external power switch. If amplifier is working properly, the balancing motor will move the pen up or downscale (depending upon phase). Reversing the cable plugs on the Dynaprobe will cause the balancing motor to move the pen in the opposite direction.

If the balancing motor does not move the pen up or downscale, disconnect the excitation leads (yellow and brown wires) from the Syncroverter Switch and apply a-c from Dynaprobe to input terminals of amplifier. If instrument works, replace Syncroverter Switch.

If instrument does not work after any of the above checks, check fuse in amplifier, replace tubes and filter capacitor in amplifier. If this does not work, replace the amplifier.

b. With plug. (used on a-c bridges).

Checking amplifiers used on a-c bridges is the same as paragraph "a" above except that the Dynaprobe toggle switch should be in the a-c position in all cases and the reference to Syncroverter should be ignored.

4. Measuring System on Potentiometers. The potentiometer type of Dynamaster uses the null-balance potentiometer circuit. The measuring element (such as a thermocouple, magneto, etc.) is wired in series with the potentiometer circuit, Syncroverter contacts and primary winding of the input transformer. This means that an open circuit anywhere in the measuring circuit, slidewire, Syncroverter contacts or primary winding of the input transformer will produce the same result: no error signal in the circuit and consequently no output from the amplifier to the balancing motor.

Check carefully the particular measuring element used to see that it is functioning correctly. Check particularly the wiring connections at both the measuring element and the instrument. Disconnect the measuring element leads from the instrument and connect them to a potentiometric test set to be sure that the measuring element is producing the voltage required for the existing conditions. See separate instructions covering servicing and checking procedures for the particular measuring element used.

Caution: Never put an ohmmeter across any part of the measuring system without first disconnecting the input leads to the amplifier. The reason for this is that the ohmmeter produces a relatively high current and would damage the Syncroverter contacts.

Assuming that the measuring element and its leads have been eliminated as the source of trouble; proceed as follows:

Check to see that the slidewire brush arm makes good contact with the slidewire (contact pressure is 35-45 grams). Try cleaning slidewire with Bristol cleaning fluid. Allow to dry. Then apply a small amount of Cramolin to slidewire and wipe off excess with a clean lint free cloth.

Caution: If any solvent other than Bristol's cleaning fluid is used to clean slidewire, it must be a type that will not leave a residue or one that attacks varnish.

If the above checks have been performed and the instrument still fails to function, the possible fault may be either an open circuit or a short circuit somewhere in the measuring system. Look for loose or poor connections or possibly a dab of solder that might short out two connections.

5. Measuring System on D-C Bridges. On a d-c bridge, the measuring element is wired so as to form one leg of the bridge. An open circuit anywhere in the bridge will produce an infinite resistance, driving the pen to the top or bottom of the chart depending upon what portion of the bridge is open circuited. If an open circuit is suspected, it can easily be checked with an ohmmeter. See separate instructions covering servicing and checking procedures for the particular measuring element used.

Caution: Never put an ohmmeter across any part of the measuring system without first disconnecting the input leads to the amplifier. The reason for this is that the ohmmeter produces a relatively high current and would damage the Syncroverter contacts.

Assuming that the measuring element and its leads have been eliminated as the source of trouble, proceed as follows:

a. Check output voltage of bridge voltage source (7 to 9 volts d.c.).

b. Check to see that the slidewire brush arm makes good contact with the slidewire (contact pressure is 35-45 grams). Try cleaning slidewire with Bristol's cleaning fluid. Allow to dry. Then apply a small amount of Cramolin to slidewire and wipe off excess with a clean lint free cloth.

c. Look for loose or poor connections or possibly a dab of solder that might short out two connections.

6. Measuring System on A-C Bridge. On an a-c bridge, the measuring element is wired so as to form one leg of the bridge. An open circuit anywhere in the bridge will produce an infinite resistance, driving the pen to the top or bottom of the bridge depending upon what portion of the bridge is open circuited. If an open circuit is suspected, it can easily be checked with an ohmmeter. See separate instructions covering servicing and checking procedures for the particular measuring element used.

Assuming that the measuring element and its leads have been eliminated as the source of trouble, proceed as follows:

a. Check for voltage on secondary winding of bridge transformer (7 to 9 volts).

b. Check to see that the slidewire brush arm makes good contact with the slidewire (contact pressure is 35-45 grams). Try cleaning slidewire with Bristol cleaning fluid. Allow to dry. Then apply a small amount of Cramolin to slidewire and wipe off excess with a clean lint free cloth.

Caution: If any solvent other than Bristol's cleaning fluid is used to clean slidewire, it must be a type that will not leave a residue or one that attacks varnish.

If all of the above checks have been performed and the instrument still fails to function, the possible fault may be either an open circuit or a short circuit somewhere in the measuring system. Look for loose or poor connections or possibly a dab of solder that might short out two connections.

7. The Recording System. The recording system is mechanical. It includes the chart drive and its gear train, chart feed roll, pen drive cord and associated pulleys, etc.

Check the recording system for mechanical troubles, such as loose or binding gears, pulleys, etc. Move the pen up and downscale manually by turning the balancing motor shaft (with power off). It should move freely from one end of the scale to the other.

Feed the chart manually by turning the feedroll knob counterclockwise. The tension of the feedroll clutch should be felt, but the chart should feed straight and smooth without tearing or distorting the holes. The pen should make a clean, legible record.

C. Miscellaneous Trouble-shooting Tips

In general, the following symptoms of troubles described below are caused by definite faults.

For all failures not specifically described below, follow the systematic trouble-shooting procedure outline in paragraph B.

1. **Symptom:** Pen remains stationary regardless of changes in the value of the measured variable.

Possible faults:

a. Power failure.
b. Defective line fuses.
c. Defective amplifier fuse. An amplifier fuse which burns out repeatedly generally indicates a bad rectifier tube or plug-in filter capacitor.
d. Defective tube in amplifier.
e. Defective plug-in filter capacitor.
f. Open circuit in measuring element.
g. Syncroverter switch failure.
h. Defective balancing motor.

2. **Symptom:** Pen records incorrect values.

Possible faults:

a. Defective measuring element.
b. Incorrect gain adjustment.

3. **Symptom:** Pen fails to record properly.

Possible Faults

a. Kink in capillary tubing.
b. Pen nib not at right angles to chart.
c. Failure of ink flow.

Check entire length of capillary feed tube for kinks. If a kink is found, disconnect capillary from pen and straighten tubing.

The pen nib must be set at right angles to the chart in order to assure proper inking. If it is not, check to see if the pen has been bent in any way. If so, be careful when straightening it so as not to cause a kink.

If it is found that the pen nib does not rest on the chart, a small adjustment of the setscrew located on the right side of the pen holder, is needed. When the pen is lifted from the chart and released, it should fall of its own weight until it rests on the chart.

If the above steps have been completed and it is found that the pen still does not record, this means that there is a stoppage and the capillary system needs cleaning.

To clean the system proceed as follows.

1. Pens

Lift pen away from chart and clean out pen nib by inserting pen cleaning wire (supplied with instrument.)

2. Capillary Tubing

Note: Before starting the cleaning process, it is recommended that a piece of absorbent paper be placed under the pen to absorb any excess alcohol that might be present at the pens during cleaning process.

Fill an empty plastic ink bottle with warm water and substitute this for the standard ink bottle. Place index finger over filler hole and squeeze bottle to force water thru capillary and pen. Repeat this action to assure proper cleaning.

After cleaning the capillary, be sure to clear the capillary of water by squeezing the plastic bottle while the filler hole is open, then closing the filler hole and releasing pressure on the bottle. This will remove any residue in the capillary back into the bottle.

4. **Symptom:** Chart does not feed properly.
   Possible faults:
   a. Chart is not lined up properly.
   b. Feed-roll clutch is slipping.
5. **Symptom:** Chart speed is incorrect.
   Possible faults:
   a. Wrong change gears.
   b. Defective chart drive motor.
   c. Frequency of power supply incorrect.

D. Changing Chart Speeds

All instruments are provided with a double gear identified as gear B & C on fig. 5. Thus by reversing this double gear, two chart speeds are always available.

If a change in chart speed is desired, first check the nameplate of the chart drive motor to determine its speed in RPM or RPH.

Next, find the column for the motor you have in the table figure 10. Read down the column to find the desired chart speed; then read across the table to the right to find the change gears required. If the chart speed required is not listed in the column under the motor you have, then check in the columns for the other two motors.

It can be seen from the table that to change from one chart speed to another may require either a change in gears, a change in motors or both.

Note that gear B is always a 48 tooth gear and gear C is always a 24 tooth gear. Gear B & C are combined to form a double gear and are a permanent part of the idler gear assembly.

When changing gear A, first loosen screw, item 5, fig. 5, and move idler gear B & C out of the way. Install new gear A on drive shaft in a position to mesh properly with either gear B or C as called for in the table for the speed required. Move idler gear assembly until gear B or C meshes properly with gear A and then tighten screw item 5, fig. 5

CHART DRIVE MOTORS						CHANGE GEARS			
2 RPM 120 V. 60 CY. A10497	2 RPM 120 V. 50 CY. A11730	8 RPM 120 V. 60 CY. A10393	8 RPM 120 V. 50 CY. A11731	8 RPH 120 V. 60 CY. A10394	8 RPH 120 V. 50 CY. A11732	GEAR POSITION	TEETH	PITCH	PART NUMBER
CHART SPEED INCHES/MIN.				CHART SPEED INCHES/HR.					
3/16	3/16	3/4	3/4	3/4	3/4	A B*	12 48	64 64	A10402 A10342
1/4	1/4	1	1	1	1	A B*	16 48	64 64	A10399 A10342
3/8	3/8	1 1/2	1 1/2	1 1/2	1 1/2	A C*	12 24	64 64	A10402 A10342
1/2	1/2	2	2	2	2	A C*	16 24	64 64	A10399 A10342
3/4	3/4	3	3	3	3	A B*	48 48	64 64	A10398 A10342
1	1	4	4	4	4	A B*	64 48	64 64	A10395 A10342
1 1/2	1 1/2			6	6	A C*	48 24	64 64	A10398 A10342
2	2			8	8	A C*	64 24	64 64	A10395 A10342

* Gears B & C are combined to form a double gear

FIGURE 10. TABLE OF MOTORS AND CHANGE GEARS FOR SINGLE-SPEED CHART DRIVES.

E. Lubrication

A drop of Gulf electric motor oil is required once each year on each of the 4 ball bearing pulleys of the drive cord assembly.

1. On Multiple-point recorders only. See figure 11 and 12 for additional lubrication points on multiple-point recorders. The points identified on figure 11 require a drop of Gulf electric motor oil once a year.

There are three oil holes in the print wheel assembly. The print wheel and ink pad must be removed to gain access to two of these oil holes.

Holtzer-Cabot gear case motors, used on the multiple-switching mechanism (see fig. 12) should be oiled every 3 months with 3 cc"s of Houghton Gearlub 890 (Bristol Part no. 91982 for 2-ounce can).

Nothing else should be oiled in the Dynamaster recorder. All other bearings are either dry (and should be kept clean) or are permanently sealed and require no lubrication during their normal lifetime.

The selector-switch contacts are normally self-cleaning. If it should be necessary to clean these contacts, they should be cleaned with a cloth and a solvent such as Bristol cleaning fluid part A5700. After cleaning, the contacts should be lubricated with a very thin film of Cramolin. It is not necessary to remove the brush arm when cleaning the contacts.

The brush arms may be rotated **counterclockwise** without damaging the unit or getting the print wheel out of step. If the brush arm is ever removed, note carefully the contacts on which the brush arm rests so that it may be returned to the same position. In addition to locating the brush arm correctly, the brush arm assembly should be pressed firmly against the hub of the switch-contact plate before tightening its setscrew. This guarantees the correct pressure on the contacts. The switch-contact-plate hub has a locating pin that fits into a hole in the brush-arm assembly. In this way, if the brush arm is taken off, the brush arm can be easily and correctly returned to its synchronized position. Always push brush arm tightly against hub of contact plate before retightening its setscrew.

F. Care of the Print Wheel on Multiple-point Recorders

When the printed record becomes too light for easy reading, the ink pads should be changed. The single-color ink pad may be replaced by removing the thumb nut and sliding off the old pad. The multi-colored pads should be replaced one at a time so that the color sequence will not get mixed up. When replacing the pad holder in the multi-color unit, be sure to line up the pin in the holder with the hole in the gear and the hole in the indicating disk.

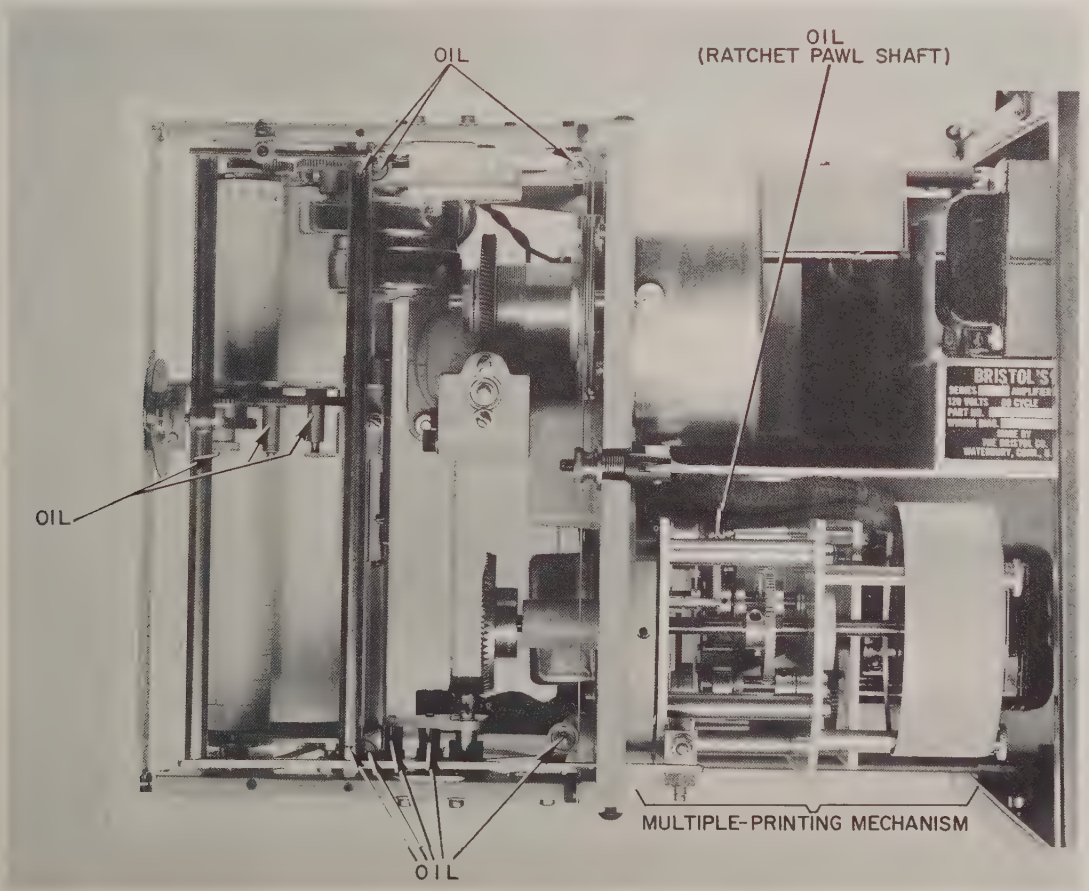

FIGURE 11. LUBRICATION POINTS ON MULTIPLE-POINT RECORDER.

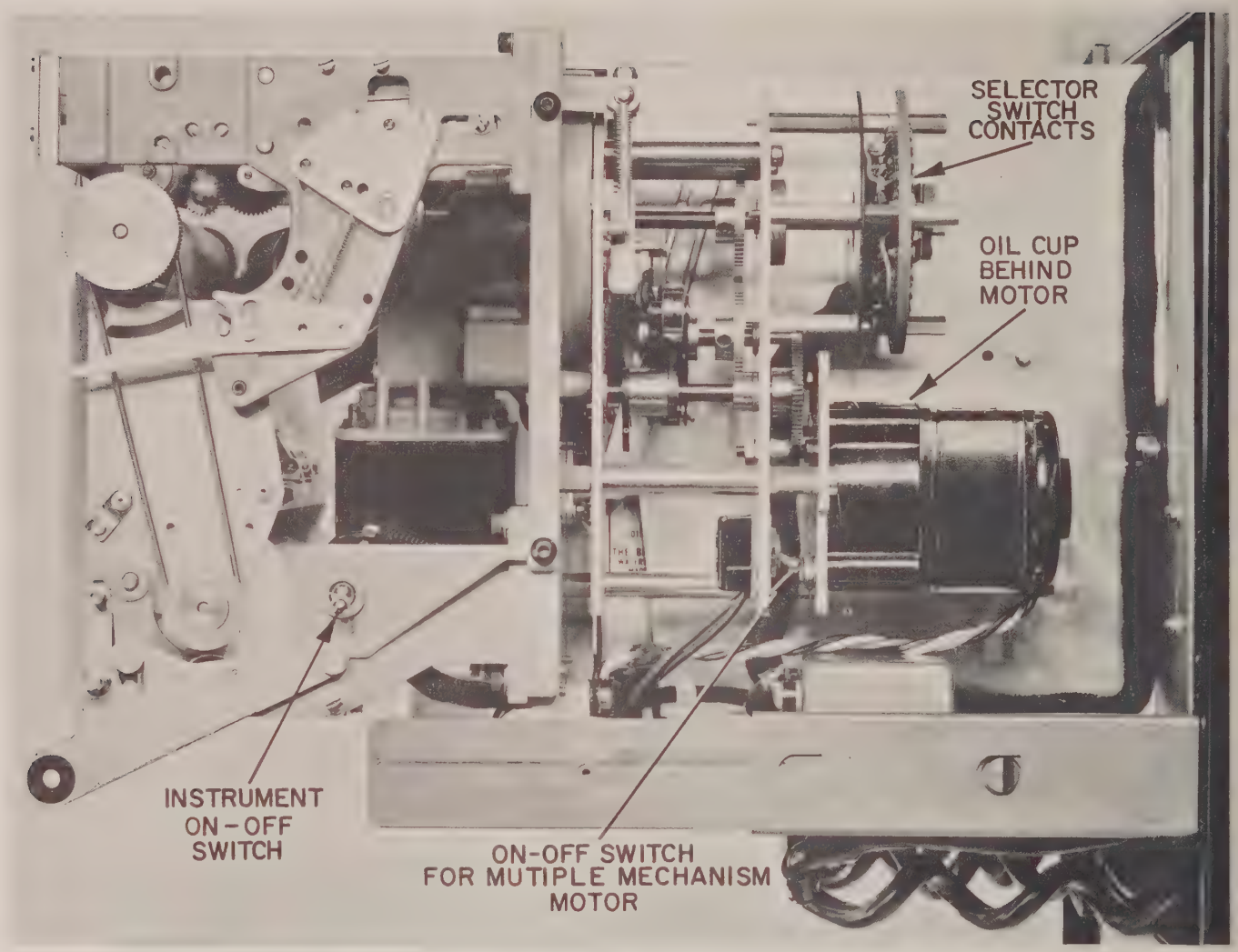

FIGURE 12. RIGHT SIDE OF MULTIPLE-POINT CHASSIS.

INSTRUCTION NO. P12606

ISSUE OF 12/64

SERVICE INSTRUCTIONS FOR SERIES L & L10 AMPLIFIERS

A. Introduction

This instruction covers the service of the series L amplifiers used on Bristol Dynamasters.

Service work on electronic circuits is a specialized technique requiring special test equipment. Only a qualified electronic technician should attempt service inside the amplifier chassis. It is strongly recommended that amplifiers be returned to the Bristol Company for repair if a qualified technician is not available.

B. Test Equipment

A multi-range volt ohmmeter with ranges of 0 to 50 and 0-500 volts d-c, 0 to 4,000 and 0 to 500,000 ohms resistance, voltage sensitivity 20,000 ohms per volt.

C. D-C Voltmeter Check

1. Disconnect all leads to amplifier and remove amplifier from instrument. The amplifier may be removed by loosening the single mounting screw located in the center of the chassis.

2. Connect 117 volt, 60 cycle supply to power plug terminals 5 and 6.

3. Connect a 1000-ohm, 10-watt resistor across output terminals 1 and 2 on power plug. This simulates the motor load.

Caution: Do not operate amplifier without the 1000 ohm 10 watt resistor across the output terminals.

4. Turn gain control to zero (extreme clockwise position.

5. Connect negative lead of voltmeter to the ground connection on the amplifier. Test with the other voltmeter lead at the points listed in the table Figure 1.

Warning: There are dangerous voltages in the amplifier. Never touch any part with bare hands unless power is off.

The voltages given in the table were taken with a 20,000 ohm per volt meter and with a line voltage of 117 volts. If the line voltage is greater or less than 117 volts, the d-c voltages given in the table will vary proportionally.

Note: Be sure to turn the gain control up again before placing the amplifier back in the instrument. The instrument would be inoperative with the gain in its zero position.

MEASURE		CORRECT VOLTAGE	RECOMMENDED CORRECTION	
FROM	TO		IF VOLTAGE IS TOO LOW	IF VOLTAGE IS TOO HIGH
B6	GND	300 ± 30	Check diodes IN2071 No voltage-Replace fuse F1	Replace V_3
B5	GND	295 ± 30	Check diodes IN2071 Replace plug-in capacitor	Replace V_3
B4	GND	260 ± 25	Check diodes IN2071 Replace plug-in capacitor	Replace V_1 or V_2
B3	GND	200 ± 20	Check diodes IN2071 Replace plug-in capacitor	Replace V_1 or V_2
B1-2	GND	160 ± 15	Replace plug-in capacitor Check C19	Replace V_1
P5	GND	270 ± 25	Check voltage at B5	Replace V_3
P4	GND	225 ± 22	Check voltage at K4	Check R19
P3	GND	120 ± 12	Check voltage at K3	Check R15
P2	GND	95 ± 10	Check voltage at K2	Check R7
P1	GND	95 ± 10	Check voltage at K1	Check R3
K5	GND	10 ± 1	Check C14	Check R23
K4	GND	2.75 ± .2	Check C11 and R19	Check R18
K3	GND	1.1 ± .2	Check C9	Check R14
K2	GND	.9 ± .1		Check R6
K1	GND	.9 ± .1	Check C1	Check R2

FIGURE 1. TABLE OF D-C VOLTAGE CHECKS

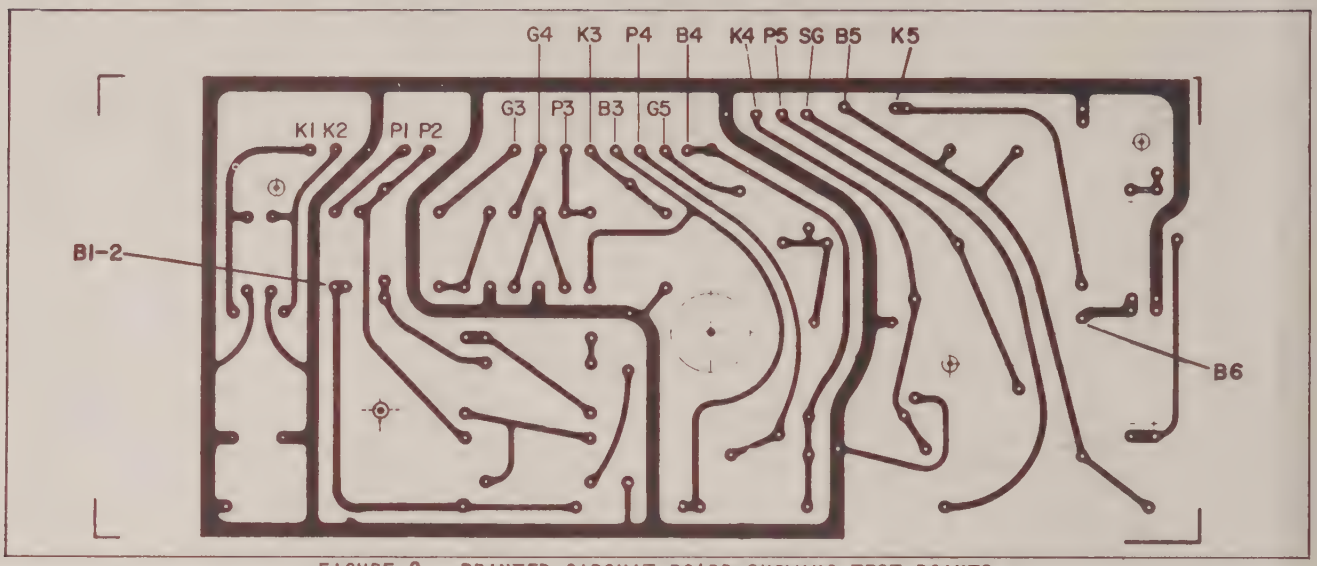

FIGURE 2. PRINTED CIRCUIT BOARD SHOWING TEST POINTS

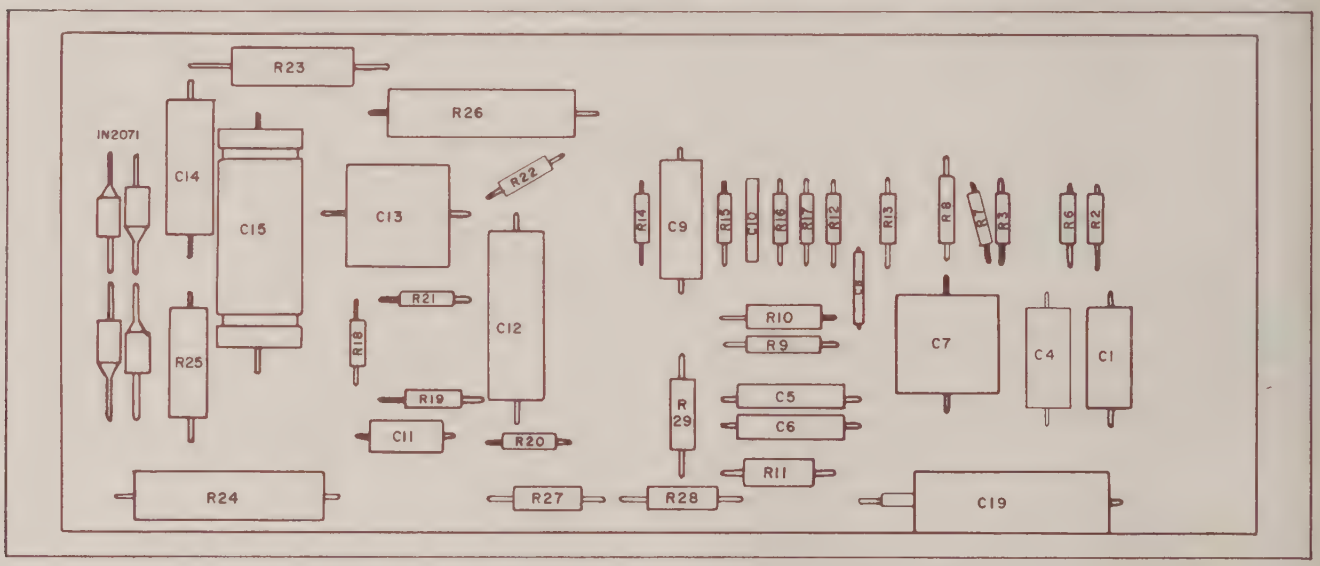

FIGURE 3. COMPONENT SIDE OF PRINTED CIRCUIT BOARD

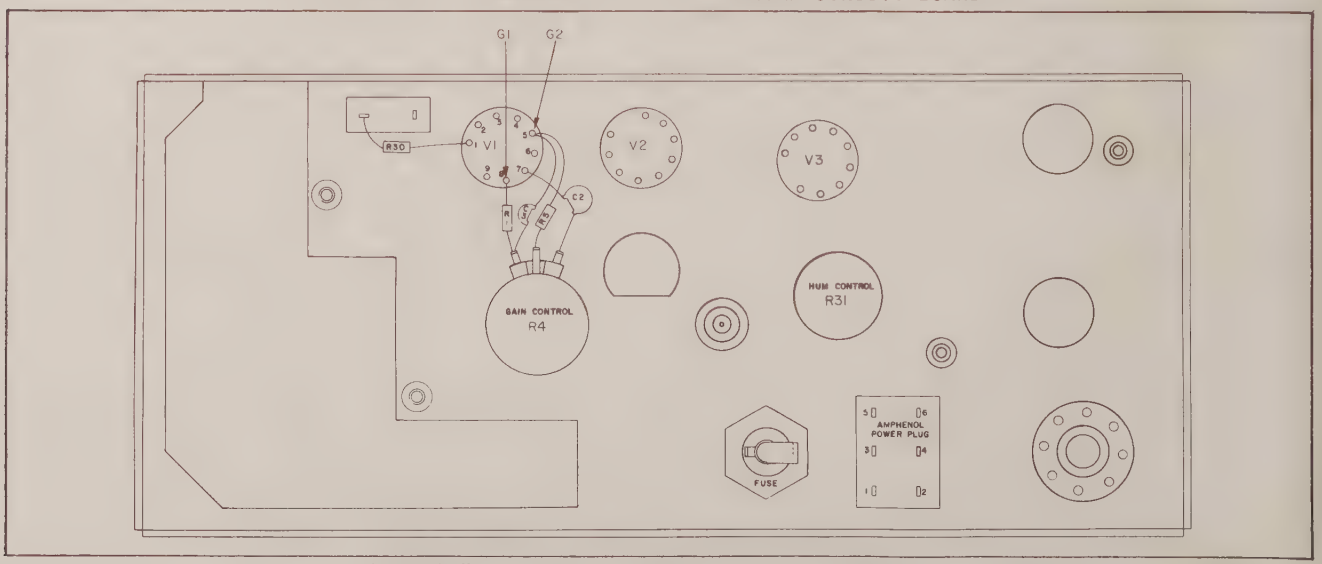

FIGURE 4. BOTTOM VIEW OF AMPLIFIER CHASSIS

MISCELLANEOUS

T1 TRANSFORMER 10,000Ω BRISTOL* B2776
1000Ω BRISTOL* B2776-1
100Ω BRISTOL* B2776-2
HI IMPEDANCE BRISTOL* B2776-3
T2 TRANSFORMER, PRIMARY 117 V.
SECONDARY 0-260, 40 MA.
SECONDARY 6.3V. 1.5AMP.
SYNCROVERTER SWITCH BRISTOL* C1415-2.
DIODES: IN2071
F1 FUSE: LITTLE FUSE 1/8 AMP. SLO.BLO.

RESISTORS

R1 RESISTOR 4.7MEG. 1/2W. ±10% TOL.
R2 RESISTOR 3·3KΩ 1/2W ±10% TOL.
R3 RESISTOR 220KΩ 1/2W ±10% TOL.
R4 RESISTOR 1MEG. POT. CTS. CURVE A.
R5 RESISTOR 1MEG. 1/2W. ±10% TOL.
R6 RESISTOR 3·3K Ω 1/2W. ±10% TOL.
R7 RESISTOR 220KΩ 1/2W. ±10% TOL.
R8 RESISTOR 300KΩ 1/2W. ±2% TOL.
R9 RESISTOR- 240K Ω 1/2W ± 2% TOL.
R10 RESISTOR-CALIBRATION 1W. ±10% TOL.
R11 RESISTOR 68KΩ 1W ±10% TOL.
R12 RESISTOR 470KΩ 1/2W. ±10% TOL.
R13 RESISTOR 1MEG. 1/2W. ±10% TOL.
R14 RESISTOR 3·3K Ω 1/2W. ±10% TOL.
R15 RESISTOR 220KΩ 1/2W. ±10% TOL.
R16 RESISTOR 470K Ω 1/2W. ±10% TOL.
R17 RESISTOR 1MEG. 1/2W. ±10% TOL.
R18 RESISTOR 6.8K Ω 1/2W. ±5% TOL.
R19 RESISTOR 680KΩ 1W ±5% TOL.
R20 RESISTOR 470KΩ 1/2W. ±10% TOL.
R21 RESISTOR 1MEG. 1/2W. ±10% TOL.
R22 RESISTOR 10K Ω 1/2W. ±10% TOL.
R23 RESISTOR 400Ω 3W. ±5% TOL.
R24 RESISTOR 10K Ω 7W ±5% TOL.
R25 RESISTOR 250Ω 3W ±5% TOL.
R26 RESISTOR 22K Ω 10W ±5% TOL.
R27 RESISTOR 56K Ω 1W ±10% TOL.
R28 RESISTOR 68KΩ 1W. ±10% TOL.
R29 RESISTOR-CALIBRATION 1W. ±10% TOL.
R30 RESISTOR 33Ω 3W ± 5% TOL.
R31 RESISTOR 500Ω POT. C.T.S. SERIES 112.

CAPACITORS

C1 CAPACITOR 50 MFD. 15V. (ELEC.) $+\frac{10}{150}$ TOL.
C2 CAPACITOR .02 MFD. 1000V. (CER.) ±20% TOL.
C3 CAPACITOR 470MMFD 1000V. (CER.) ±10% TOL.
C5 CAPACITOR, 0062 MFD. (MICA) ± 5% TOL.
C6 CAPACITOR, 0062 MFD. (MICA) ± 5% TOL.
C7 CAPACITOR, 0062 MFD. (MICA) ± 5% TOL.
C8 CAPACITOR .02 MFD. 1000V. (CER.) ±20% TOL.
C9* CAPACITOR 50 MFD. 15V. (ELEC.) $+\frac{10}{150}$ % TOL.
C10 CAPACITOR, .02 MFD 1000V. (CER) ±20% TOL.
C11* CAPACITOR 1 MFD. 6V. (ELEC.) $+\frac{10}{150}$ % TOL.
C12 CAPACITOR .022 MFD. 600V (PAPER) 10% TOL.
C13 CAPACITOR .003 MFD. 500V. (MICA) ± 2% TOL.
C14 CAPACITOR 50 MFD. 25V. (ELEC.) $+\frac{10}{150}$ % TOL.
C15 CAPACITOR .25 MFD. 600V. (PAPER) ±20% TOL.
C16 CAPACITOR 10 MFD. 450V. (ELEC.) $+\frac{10}{150}$ % TOL.
C17 CAPACITOR 10 MFD. 450V. (ELEC.) $+\frac{10}{150}$ % TOL.
C18 CAPACITOR 10 MFD. 450V. (ELEC.) $+\frac{10}{150}$ % TOL.
C19 CAPACITOR 12 MFD. 250V. (ELEC.) $+\frac{10}{150}$ % TOL.

* DENOTES SPRAGUE LITTL LYTICS

TUBES

V1	6EU7	MFG. RCA
V2	6EU7	MFG. RCA.
V3	6BQ5	

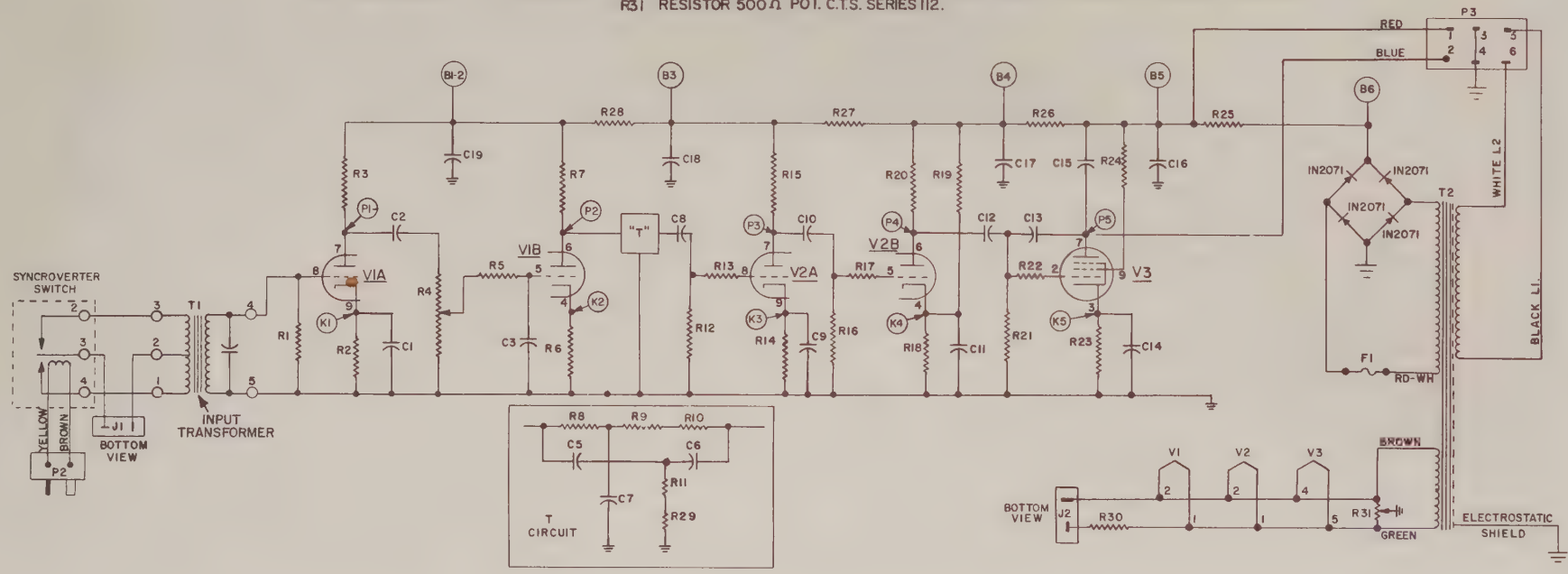

FIGURE 5. SCHEMATIC WIRING OF SERIES L AMPLIFIER

MISCELLANEOUS

T2 TRANSFORMER, PRIMARY 117 V.
SECONDARY 0-260, 40 MA.
SECONDARY 6.3 V. 1.5 AMP.
DIODES: IN2071
F1 FUSE: LITTLE FUSE 1/8 AMP. SLO. BLO.

RESISTORS

R1 RESISTOR 4.7 MEG 1/2 W. ±10% TOL.
R2 RESISTOR 3.3 KΩ 1/2 W ±10% TOL.
R3 RESISTOR 220 KΩ 1/2 W ±10% TOL.
R4 RESISTOR 1 MEG. POT. CTS. CURVE A
R5 RESISTOR 1 MEG. 1/2 W. ±10% TOL.
R6 RESISTOR 3.3 KΩ 1/2 W. ±10% TOL.
R7 RESISTOR 220 KΩ 1/2 W. ±10% TOL.
R8 RESISTOR 300 KΩ 1/2 W. ±2% TOL.
R9 RESISTOR 240 K Ω 1/2 W ±2% TOL.
R10 RESISTOR - CALIBRATION 1 W. ±10% TOL
R11 RESISTOR 68 K Ω 1 W ±10% TOL.
R12 RESISTOR 470 K Ω 1/2 W. ±10% TOL.
R13 RESISTOR 1 MEG. 1/2 W. ±10% TOL.
R14 RESISTOR 3.3 K Ω 1/2 W. ±10% TOL.
R15 RESISTOR 220 K Ω 1/2 W. ±10% TOL.
R16 RESISTOR 470 K Ω 1/2 W. ±10% TOL.
R17 RESISTOR 1 MEG. 1/2 W. ±10% TOL.
R18 RESISTOR 6.8 K Ω 1/2 W. ±5% TOL.
R19 RESISTOR 680 K Ω 1 W ±5% TOL.
R20 RESISTOR 470 K Ω 1/2 W. ±10% TOL.
R21 RESISTOR 1 MEG. 1/2 W. ±10% TOL.
R22 RESISTOR 10 K Ω 1/2 W. ±10% TOL.
R23 RESISTOR 2 K Ω 3 W. ±5% TOL.
R24 RESISTOR 10 K Ω 7 W ±5% TOL.
R25 RESISTOR 250 Ω 3 W ±5% TOL.
R26 RESISTOR 22 K Ω 10 W ±5% TOL.
R27 RESISTOR 56 K Ω 1 W ±10% TOL.
R28 RESISTOR 68 K Ω 1 W. ±10% TOL.
R29 RESISTOR - CALIBRATION 1 W. ±10% TOL.
R30 RESISTOR 33 Ω 3 W ± 5% TOL.
R31 RESISTOR 500 Ω POT. C.T.S. SERIES 112.
R32 RESISTOR 150 K Ω ½ W ± 10 % TOL.

CAPACITORS

C1 CAPACITOR 50 MFD. 15 V. (ELEC.) $^{+10}_{+150}$ TOL.
C2 CAPACITOR .02 MFD. 1000 V. (CER.) ±20% TOL.
C3 CAPACITOR 470 MMFD 1000 V. (CER.) ±10% TOL.
C4 CAPACITOR 50 MFD. 15 V. (ELEC.) $^{+10}_{+150}$ TOL.
C5† CAPACITOR .0062 MFD. (MICA) ± 5% TOL.
C6† CAPACITOR .0062 MFD. (MICA) ± 5% TOL.
C7† CAPACITOR .0062 MFD. (MICA) ± 5% TOL.
C8 CAPACITOR .02 MFD. 1000 V. (CER.) ±20% TOL.
C9* CAPACITOR 50 MFD. 15 V. (ELEC.) $^{+10}_{+150}$ % TOL.
C10 CAPACITOR .02 MFD 1000 V. (CER) ±20% TOL.
C11* CAPACITOR 1 MFD. 6 V. (ELEC.) $^{+0}_{+150}$ % TOL.
C12 CAPACITOR .022 MFD. 600 V (PAPER) 10% TOL.
C13 CAPACITOR .0062 MFD. 500 V. (MICA) ± 2% TOL.
C14 CAPACITOR 50 MFD. 50 V. (ELEC.) $^{+10}_{+75}$ % TOL.
C15 CAPACITOR .25 MFD. 600 V. (PAPER) ±20% TOL.
C16 CAPACITOR 10 MFD. 450 V. (ELEC.) $^{+10}_{+150}$ % TOL.
C17 CAPACITOR 10 MFD. 450 V. (ELEC.) $^{+10}_{+150}$ % TOL.
C18 CAPACITOR 10 MFD. 450 V. (ELEC.) $^{+10}_{+150}$ % TOL.
C19 CAPACITOR 12 MFD. 250 V. (ELEC.) $^{+10}_{+150}$ % TOL.

* DENOTES SPRAGUE LITTL LYTICS

TUBES

V1 6EU7 MFG. RCA
V2 6EU7 MFG. RCA.
V3 6BQ5

† C5, C6, C7 ARE .0075 MFD. FOR 50 CY. AMPLIFIERS

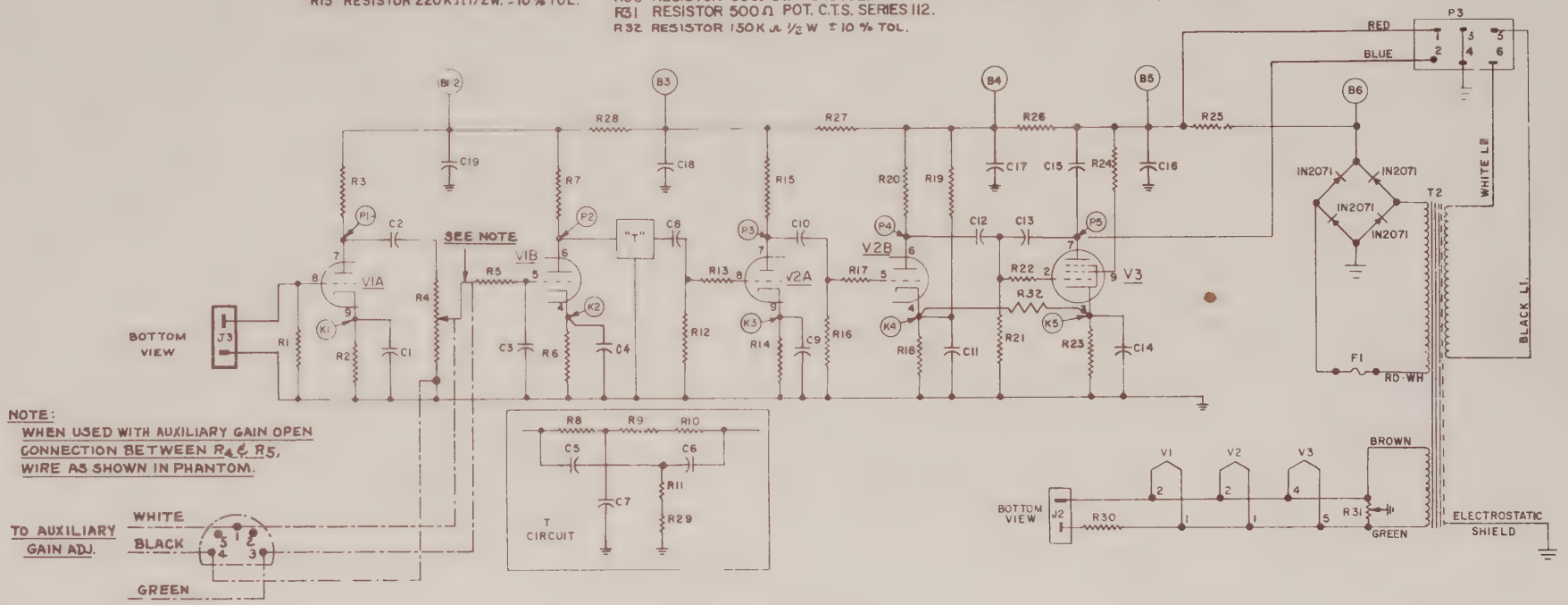

FIGURE 6. SCHEMATIC WIRING OF SERIES L10 AMPLIFIER

INSTRUCTIONS P12500

INSTALLATION & SERVICE OF THERMOCOUPLES, EXTENSION WIRE & PROTECTING TUBES

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THE BRISTOL COMPANY WATERBURY, CONNECTICUT 06720

PART I PYROMETER PRINCIPLES

A. THERMOCOUPLE PRINCIPLES

If the two junctions in a closed electric circuit made of two dissimilar conductors are at different temperatures, an electromotive force (emf) will be generated, proportional to that temperature difference. In the fundamental thermal circuit (See Fig. 1) the temperatures T_1 and T_2 differ, so an electromotive force develops between the dissimilar metals A and B. An instrument may be used to measure this emf between the pair of junctions. This is the basic circuit and principle of all thermoelectric thermometers.

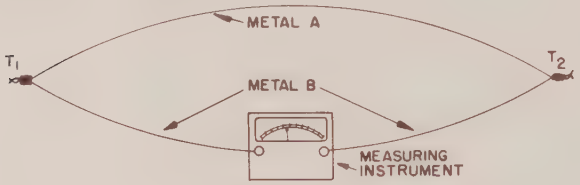

FIG. 1. THE FUNDAMENTAL THERMO-ELECTRIC PYROMETER CIRCUIT.

B. EXTENSION WIRE PRINCIPLES

It must not be overlooked that the measuring junction or "hot" junction is **only one half** the thermocouple and thus the pyrometer is reading not the temperature of this measuring junction but the **temperature difference between the measuring and reference junction.** Therefore, variations in the reference junction affect the instrument reading no less than those in the measuring junction. In the early days the reference or cold end junction was held at constant temperatures by burying it deep in the ground, using a control temperature box and other devices. Today the cold junction temperature is allowed to vary, but mechanical or electrical compensation is introduced into the pyrometer reading. The connections between extension wires and the couple and instrument are also junctions in the pyrometer circuit, whose temperature may vary widely. To prevent introduction of extraneous emf's from such junctions, extension wire must be either of the same metals as the measuring junction itself, or of metals with the same thermoelectric properties. For economics sake, especially with platinum thermocouples, extension leads are made of inexpensive alloys having emf characteristics matching the couples with which they are used.

PART II INSTALLATION

A. GENERAL

Interior temperature of ovens, tanks, baths etc., may vary widely from point to point. Therefore of first importence is the location of the couple so that it acquires the temperature to be measured. A test to determine this correct installation point may be made with a portable thermocouple before the permanent installation is placed. Turbulence of the measured medium at the couple tip should be high if possible to increase heat transfer to the couple. Direct flame with its reducing atmosphere should be avoided. The space between furnace wall and protection tube and other adjacent holes should be cemented to prevent either cooling of the couple by entering cold air or over-heating of the terminal head by escaping hot gases. If possible, install the couple so that the hot end of the tube can be inspected from the furnace door. For temperatures above 1500°F., we recommend that couples and tubes be vertically suspended thru the crown or roof of ovens or furnaces as bending of both metal and ceramic wells is likely at temperatures near their upper limits, if otherwise installed.

1. Thermocouple Installation (see drawings of typical installations).

The entire couple junction should be inserted at least 10 diameters of the protecting tube beyond the inside surface of the furnace or beneath the surface of a liquid or molten metal.

Thermocouple should be preheated before installation in a hot furnace to avoid breakage of the porcelain insulators due to thermal shock. A thermocouple which is to be permanently installed should be mounted firmly with proper support. It must be protected from mechanical injury and should not be subjected to severe jarring. Never locate a thermocouple in a furnace or oven where it will

be subjected to direct flame impingement. The life of the protecting tube will be materially shortened and the temperature readings will not be representative of the normal furnace atmosphere.

Once a thermocouple is installed in a furnace it should not be removed or disturbed. If it is desired to check the calibration of the couple, a second couple should be inserted in the furnace so that the tips touch each other. If a couple is removed from a furnace and used elsewhere, the depth of immersion may differ and the heated portion of the wire will be in a different temperature gradient, causing an error. It is better to obtain a new couple rather than transfer an old one to another application.

Couples used in liquids or in molten metals, pots, kettles, etc., are best mounted so that they may be conveniently withdrawn at any time for inspection or testing. Suspension of such couples by chains, pulleys, and counter balances is recommended so that they may be quickly removed while charging the pots. No metallic protecting tube will indefinitely resist the corrosive action of molten aluminum or aluminum alloys. Refractory tubes are too liable to breakage, on the other hand, to be practical. Many foundries follow the practice, therefore, of daily painting metallic tubes with a thick white wash solution. Paints of sodium silicate and silicon carbide mixtures are also used. If necessary tubes of the cold extension type as illustrated in Fig. 13 or the angle type Fig. 12 should be used so that the terminal head may be located in a cool accessible spot for testing and inspection of the couple and connection.

Distortion of couple junction by rolling, twisting or hammering will cause calibration changes due to molecular rearrangement in the couple metal. The electrical welding process employed by The Bristol Company in making thermocouple junctions avoids mechanical working and substantially reduces this source of calibration error. Calibration is also affected by excess vibration, and the frequency and degree of heating and cooling.

2. Extension Wire Installation

Connect the extension wires to the thermocouple by means of the terminals provided, the other end of the extension going to the instrument binding posts. When connecting a thermocouple and extension to an instrument the polarity must be strictly observed i.e.; positive (+) to positive and negative (-) to negative. (See Figure 3).

CAUTION: Always use extension wires specifically designed for the kind of couple being used. Never use plain copper wires or extension wires intended for another kind of thermocouple.

For all permanent installations, we recommend that a covered terminal head be used with all extension wires contained in conduit, which connects directly into rotary switches, instrument cases and the thermocouple head. If flexibility is necessary use a flexible armored extension wire.

CAUTION: Extension wires should never be installed parallel to or crossing within 12 inches of an a-c power line and all conduit should be grounded to prevent induced currents. All splices in extension wires should be carefully soldered and carefully taped.

CONDUIT SIZE (INCHES)	APPROXIMATE NUMBER OF PLASTIC AND BRAID INSULATED DUPLEX ENTENSION WIRES ACCOMODATED BY CONDUIT.				
	#8	#10	#12	#14	#16
1/2	1	1	1	2	4
3/4	2	2	3	4	6
1	3	4	5	6	9
1-1/4	6	7	8	10	20
1-1/2	9	12	13	15	26

FIG. 2. A GUIDE TO THE SIZE OF CONDUIT FOR EXTENSION WIRE.

THERMOCOUPLE		EXTENSION WIRE		COLOR CODE	
ISA CODE	FORMER CODE	CODE	MATERIAL	INDIVIDUAL	OVERALL
J	IC	JX	+ Iron - Constantan	white red	black
T	24B	TX	+ Copper - Constantan	blue red	black
K	25H	VX	+ Copper - Constantan	brown red	red
K	25H	KX	+ Chromel - Alumel	yellow red	yellow
S	27	SX	+ Copper - Special Alloy	black red	green
R	32	SX	+ Copper - Special Alloy	black red	green

FIG. 3. COLOR CODE OF EXTENSION WIRES

a. Installation Millivoltmeter Pyrometers. Millivoltmeter type pyrometers are calibrated for a definite external resistance (sometimes called C + L which is the total resistance of the thermocouple and extension wire. The external resistance is marked on the scale plate of the instrument. Standards for current models call for 2 ohms external resistance unless order specifies otherwise. Uncalibrated extension wire will result in an error of less than 1% on these instruments if extension lengths do not exceed 30 ft. of duplex no. 14 wire. Therefore, in most cases, uncalibrated extension can be used with all modern high resistance millivoltmeter pyrometers. Exceptions to this are when extension wires are long, in which case calibrating for a higher external resistance should be specified or when exceptional accuracy is required, in which case the extension wire should be calibrated to match the instrument. The internal resistance of the instrument is marked on the scale plate. This resistance is measured across the binding posts.

CAUTION: Never use an ohmmeter to measure the resistance of a millivoltmeter movement. Use a potentiometer type test set.

A high resistance millivoltmeter pyrometer has an internal resistance above 150 ohms. A low resistance instrument has an internal resistance of less than 50 ohms.

Any change in external resistance will cause a much more serious error in the instrument having a low internal resistance than one with a high internal resistance. Changes in the line and couple resistance of as much as 2 or 3 ohms are not uncommon in practice and may be caused by oxidation of the thermocouple wires, poor contacts or connections, variable depth of immersion of the thermocouple, temperature variations in the extension wire and structural faults in the wire.

b. Installation Potentiometer Pyrometer. It is unnecessary to calibrate extension wire when used with a potentiometer type pyrometer. The reason for this is that when the instrument is at balance, the instrument draws no appreciable current and therefore produces no measurable voltage drop in the extension wires.

B. THERMOCOUPLE TYPES

Metals for thermocouples are selected to give the largest possible emf, which increases with an almost linear relationship to temperature, while possessing resistance to melting, corrosion and changes in emf characteristics during use. While platinum, which was used for most early couples, possesses all the above desirable qualities, its high cost makes very desirable the substitution of less expensive "base metal" thermocouples. Therefore in 1905 The Bristol Company developed the first practical base metal thermocouple. Since then many variations of base metal thermocouples have been developed and by continued research the number of base metal thermocouples now in use has been reduced to three.

1. The iron constantan, "J" couple with positive wire of iron and negative wire of constantan, an alloy of approximately 55% copper and 45% nickel is recommended for reducing atmospheres. The operating range for the J couple is 1600°F maximum for the largest wire size and lower for the smaller sizes. See Figure 4.

Before the standard J couple had been adopted by the pyrometer industry, The Bristol Company made thermocouples of pure iron and of constantan of slightly different emf characteristics, known as the "18B" curve" which can still be furnished on order in any type or form, as replacement for existing instruments.

2. The copper constantan couple (Bristol T Curve or the Adams Curve per NBS RP1080), with positive wire of copper and negative wire of constantan is recommended for use in mildly oxidizing and reducing atmospheres thru 650°F, applications where moisture is present and for low temperature work down to -300°F. This couple is recommended for temperatures below 400°F or 200°C because its emf curve is more linear than the J couple in this range.

3. The Chromel-Alumel Couple (Bristol K curve) with positive wire of chromel (an alloy of approximately 90% Ni and 10% Cr.) and the negative wire of alumel (an alloy of approximately 95% Ni, 5% Al., Mn and Si) is recommended for use in clean oxidizing atmospheres. Because it gives high emf temperature curves and its high nickel content provides oxidation resistance, the K couple is the most practical and widely used.

4. Platinum Thermocouples. Two types of noble metal couples are in use, first the LeChatelier, with negative wire of pure platinum and positive wire of 90% platinum and 10% rhodium (Bristol S Curve), second the "87-13 type thermocouple (Bristol R Curve). Because the 90-10 platinum rhodium-platinum couple is used in defining the international temperature scale and by the National Bureau of Standards, it is offered as the standard by The Bristol Company. However we can furnish the 87-13 type platinum couple on order.

C. THERMOCOUPLE INSULATION

Three kinds of insulation can be supplied with Bristol Thermocouples, the asbestos, procelain and glass fibre. Asbestos insulation is molded on bare wires. Porcelain insulation is recommended for use above 1600°F or 850°C as asbestos insulation becomes brittle above this temperature. Asbestos insulation is frequently preferred with angle type thermocouples for ease in replacement of elements which can be bent as required on the job. Glass fibre may be used up to 900°F.

D. FACTORS AFFECTING THERMOCOUPLE ACCURACY

1. Location - see general installation instructions and installation illustrations.

2. Conduction Error - Heat conduction away from the measuring junction along the protection tube and couple wires will cause serious errors in temperature reading unless the entire couple junction is inserted at least 10 diameters of the protection tube beyond the inside surface of the furnace or beneath the surface of a liquid or of molten metal. It may be concluded that immersion is sufficient to achieve this accuracy, if no noticeable change in temperature reading occurs upon withdrawing the couple 1 inch from its protection tube. With very high temperatures, to prevent couple melting, only partial immersion may be used. For examples see Fig. 13. Furnace temperature variations may thus be measured and even heat control thus accomplished, but obviously with partial immersion of the thermocouple, true temperatures are not obtained. Many suggested types of installation are shown further on in this book.

3. Corrosion & Poisoning. Accuracy of thermocouples will be rapidly and seriously destroyed by poisoning, alloying or contamination of the couple metal. See paragraph on corrosion and poisoning in section under factors affecting thermocouple life.

E. FACTORS AFFECTING THERMOCOUPLE LIFE

In general the following four factors affect the life of the thermocouple in the order given and should be so considered when selecting a couple.

1. Temperature. The following table gives a conservative guide to minimum and maximum temperature of the standard type couples.

TYPES OF THERMOCOUPLE	TEMPERATURE RANGES	
	°C	°F
Platinum-Platinum Rhodium S or R Curve		
#24 AWG (20 Mill)	0-1482	0-2700
Chromel-Alumel (K)		
#8 AWG	0-1262	0-2300
#14 AWG	0-1093	0-2000
#20 AWG	0-982	0-1800
Iron Constantan (J)		
#8 AWG	0-760	0-1400
#14 AWG	0-593	0-1100
#20 AWG	0-482	0-900
Copper-Constantan (T)		
#14 & #20 AWG	-183 to +345	-300 to +650

FIG. 4. MAXIMUM CONTINUOUS TEMPERATURE LIMITS (COUPLE IN WELL).

For temperatures above 2650°F or 1450°C the radiation type of thermocouple is recommended.

2. **Corrosion and Poisoning.** The oxidizing and reducing effects of air and of furnace atmosphere, corrosion by chemicals, fumes etc. are very common causes for couple failure. Should there be any question whether an atmosphere is oxidizing or reducing a simple test can be performed. See Part III Service.

a. **Iron constantan (J)** thermocouples should be used in a reducing atmosphere. The life of both the iron and constantan legs will remain substantially the same, except in oxidizing atmospheres. In this case the iron will deteriorate more rapidly than the constantan.

b. **Copper constantan (T)** thermocouples withstand oxidation in temperatures up to 650°F. Beyond this temperature the copper leg commences to oxidize rapidly.

c. **Chromel-Alumel (K)** thermocouples should be used in clean oxidizing atmospheres. Sulphur in an atmosphere will rapidly contaminate a chromel-alumel thermocouple causing calibration errors and rapid failure. Where it is known there is a high sulphur content such as found in burning Bunker C oil or natural gas, special protection wells or tubes should be ordered for the thermocouples. In using powdered coal as a source of heat for certain high temperature applications, the atmosphere may contain sulphur and carbon in their many states. Unless adequate protection is provided, the couple will undergo extremely rapid deterioration known as "green rot". Further, the protection tubes used for chromel-alumel thermocouples should be clean and free of any traces of core sand, oil or other organic materials that form carbon and reducing agents at high temperatures. Where doubt exists concerning the cleanliness of such a tube it should be heated in a furnace at or near 1500°F for several hours to burn off any organic matter present. The choice of insulators used on chromel-alumel thermocouples may also affect the life of the thermocouple. Presence of the so called "alkaline earths" such as sodium and phosphorous would contaminate a chromel-alumel thermocouple, cause a calibration shift and shortened life. Insulators furnished by The Bristol Company are cleaned to remove contaminating matter.

d. **Platinum Rhodium-Platinum (S or R) Thermocouples** in general have a high resistance to oxidation and corrosion. However, hydrogen, carbon and many metal vapors found in furnace atmospheres will seriously contaminate a platinum rhodium platinum thermocouple. Therefore a gas tight, non-metallic protection tube should be used.

3. **Couple Wire Size.** Couples made of large wire, such as No. 8 to No. 14 resist corrosion far longer than the smaller sizes but the smaller sizes are more responsive to temperature changes. Therefore in choosing the wire size for a given thermocouple, a compromise between responsiveness and life of the couple must be made based upon the requirements of the particular application.

Platinum rhodium and platinum thermocouple wire comes only in the #24 AWG size. Other couple materials are available in several sizes.

4. Mechanical Damage. Distortion of couple junction by rolling twisting or hammering will cause calibration changes due to molecular rearrangement in the couple metal. Calibration is also affected by excess vibration and the frequency and degree of heating and cooling. Obviously, the only way that these conditions can be avoided is by the proper selection of couple location and protection tubes.

F. CALIBRATED THERMOCOUPLES

Any Bristol thermocouple can be supplied, at an extra charge, either with an individual calibration curve, made in Bristol's laboratory by precision comparison against National Bureau of Standards certified couples or can be supplied with a certificate of check by the National Bureau of Standards itself. In ordering such calibrated thermocouples, be sure to specify over what temperature range the greatest accuracy is desired. We recommend that all thermocouples to be used as standards or for checking work, be ordered with one of the two above calibration curves supplied.

NOTE: When ordering certified selected thermocouples your order must read 12" greater than the length you desire. (Applies only to base metal couples).

G. PROTECTING TUBES

Thermocouples must not be immersed, without the protection of a well or protecting tube, in fluids or gases of a corrosive or erosive nature. The function of the protecting tube is to protect the couple wire against mechanical damage and corrosive or contaminating atmospheres. Protecting tube materials are chosen for their ability to withstand at high temperatures, mechanical shock and stress, sudden temperature changes, oxidation or reduction, chemical corrosion and metallic amalgamation, while at the same time providing high thermoconductivity and low porosity to gases. Since no one material possesses all these qualities it is necessary to choose a tube to suit the installation.

1. Metallic Tubes - A conservative guide for the maximum safe temperatures for various metal tubes or wells is given in Figure 5.

Metallic tubes are usually sufficient protection for base metal couples, although a single Mullite tube is frequently used with chromel-alumel couples between 2000 & 2400°F.

2. Ceramic tubes. Due to its tendency to contamination, the platinum couple cannot be used in metallic tubes but should be protected by a suitable gas tight refractory protection tube such as a mullite or fused quartz. As the refractory tubes are fragile, a secondary tube of metal or ceramic depending upon the temperature is often used outside this first or primary tube to provide mechanical protection.

TYPE OF TUBE	RECOMMENDED MAXIMUM TEMPERATURE	
	°C	°F
Seamless Steel	550	1000
Wrought iron	700	1300
Cast iron	700	1300
Chrome iron (28%)	1100	2000
Stainless steel (18% cr. -8% Ni.)	850	1600
Nichrome	1100	2000
Thermalloy (cast steel with 24 cr. 12 Ni)	1200	2200
Chromax (cast steel with 18 cr. 35 Ni)	1100	2000
Misco B (drilled steel 24 cr. 12 Ni)	1100	2000
Nickel	1100	2000
Inconel (79.5 Ni., 13 cr., 6 Fe)		
For Furnace	1260	2300
For lead bath	980	1800

FIG. 5. RECOMMENDED MAXIMUM OPERATING TEMPERATURES OF METAL PROTECTION TUBES.

PART III THERMOCOUPLE SERVICE

The accuracy of a thermocouple will depend on temperatures being measured, oxidation, contamination, the care with which a couple is made and the alloys used for the couple. As the accuracy of a thermocouple will become progressively less as the couple deteriorates it is advisable to test couples at intervals varying from once a week to once every three months, depending on the service.

Iron constantan couples change very little from time of installation to end of couple life. Chromel-Alumel couples change continuously with age.

A. TROUBLE SHOOTING PROCEDURE

One of the most frequent causes of pyrometer trouble is due to poor connections between thermocouples and instrument. When a pyrometer fails to indicate proper temperature first check connections between extension wires and instrument and between extension wires and couple. Quite frequently when first installing or replacing a couple or extension wire the connections at the couple are reversed and an error results.

1. Resistance Check. Most present day millivoltmeter instruments are high resistance movements. The external resistance on these movements is usually 2 ohms. Older type movements were of the low resistance type with an internal resistance of 100 ohms or less and usually have a calibrated extension wire with a resistance of 10 to 15 ohms.

Changes in the external resistance of as much as 2 or 3 ohms are not uncommon in practice and may be caused by oxidation of the thermocouple wire, poor connections, variable depth of immersion of the thermocouple, temperature variations in the extension wire and structural faults in the wire.

When making a resistance check disconnect extension wires from instrument. Hook up an ohmmeter across ends of extension wire. If ohmmeter reading is considerably higher than the external resistance value marked on scale plate of instrument, check resistance at the thermocouple itself. If resistance is high at couple the fault lies in the couple. If resistance is OK at couple but high at instrument end of extension wires the fault is in the extension wires.

CAUTION: Never use an ohmmeter to check the internal resistance of a Millivoltmeter type instrument. Use only a potentiometer type test set.

2. Checking a couple in service. This method is used only when a quick test is necessary and where accuracy is not important. It may be done in one of several ways.

a. Inserting test couple in a test hole near the permanent couples. It is important to duplicate the conditions of the permanent couple as closely as possible and the test couple should have the same type of protecting tube. Readings of the two couples may then be compared.

b. Inserting test couple in same protecting tube as permanent couple if there is room and comparing their readings.

c. Alternately inserting the test couple and permanent couple in same hole. Satisfactory results can only be obtained by this method when the furnace temperature is reasonably constant.

3. Check by use of Muffle Furnace. One of the most desirable methods of checking a thermocouple is by means of a small muffle furnace. Remove couple to be checked from its protecting tube and tie the hot junction to the hot junction of a test couple with asbestos string. Insert couples in the furnace and bring furnace up to a constant temperature within the temperature range in which the couple is intended to operate. When the two couples have reached a constant temperature the emf of each may be read on a test instrument connected to the couples thru a switch which permits couple to be alternately connected to test instrument.

4. Check by use of a Metal Bath. This method is satisfactory for many industrial users but is not as accurate as the muffle furnace method. Equipment includes an iron pot filled with lead or tin, covered with graphite and heated by means of a gas or electric furnace. The thermocouples to be tested, including the standard, are inserted in an iron protecting tube closed at one end, and immersed in the molten bath. Read-

ings are taken when a temperature equilibrium is reached. The practical temperature range is between 600 and 1800°F. Couples should be immersed in the bath to a depth of at least 12 inches.

5. Corrosion and Poisoning. The oxidizing and reducing effects of air and of furnace atmosphere, corrosion by chemicals, fumes etc. are very common causes for couple failure. Should there be any question whether an atmosphere is oxidizing or reducing, a simple test can be performed. Cupric oxide may be used as an indicator, provided it will not react dangerously with the application. If the cupric oxide remains black, the atmosphere in which it was placed is oxidizing. If it turns to some shade of red, the atmosphere is reducing. When the cupric oxide is placed in a protecting tube with a thermocouple and allowed to operate at high temperature, reduction of the cupric oxide may produce molten copper that will cause the thermocouple to stick to the protection tube when the assembly is withdrawn and allowed to cool. This would indicate that reducing gases have leaked thru the tube.

6. The following is a list of desirable checking equipment.

1. Potentiometer Type Test Set.
2. Ohmmeter.
3. Standard platinum couple with protecting tube.
4. Standard base metal thermocouple.
5. Electric muffle furnace or metal bath.
6. Temperature-Millivolt equivalent tables. (Included with all pyrometers).

B. CORRESPONDENCE AND INFORMATION

If difficulties arise or information is needed, write to the nearest Bristol Company branch office stating the nature of the problem and all pertinent data. For all replacements, supplies and information, it is essential to give the model and serial number of the instrument.

The Bristol Company
Waterbury 20, Connecticut

Printed in U.S.A.

SUGGESTED METHODS OF THERMOCOUPLE INSTALLATION

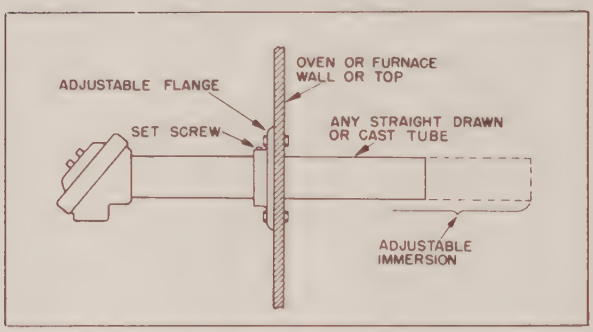

FIG. 6. SHEET METAL OVEN, FURNACE FOR DUCT WALL WITH COUPLE MOUNTED WITH ADJUSTABLE FLANGE.

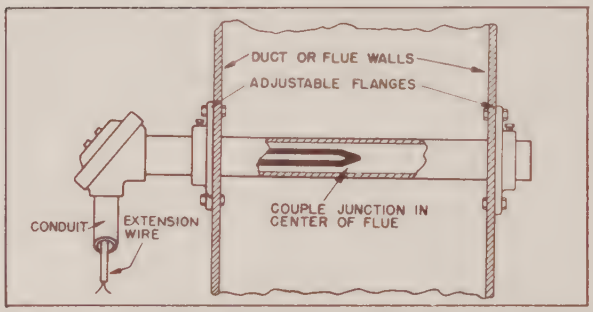

FIG. 7. BOILER BREECHING, COAL DRYER FLUE OR DUCT WITH COUPLE USING ANY STRAIGHT WELL MOUNTED FROM SIDE TO SIDE OF DUCT WITH TWO ADJUSTABLE FLANGES.

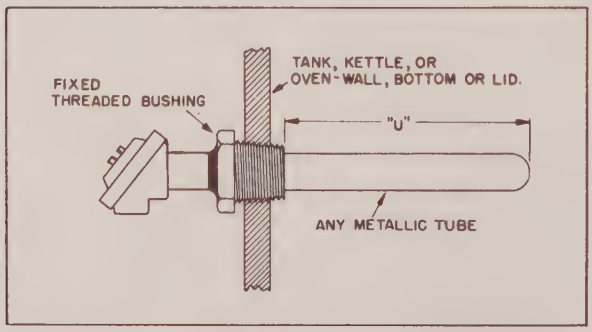

FIG. 8. TANK, KETTLE OR OVEN WITH ANY METALLIC WELL MOUNTED BY A FIXED THREADED BUSHING.

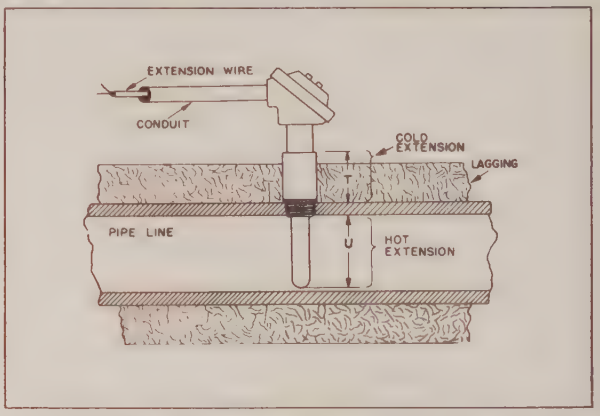

FIG. 9. HIGH PRESSURE STEAM, OIL, GAS, ETC., PIPE LINE WITH THERMOCOUPLE PROVIDED WITH EXTENSION "F" TO PASS THROUGH LAGGING.

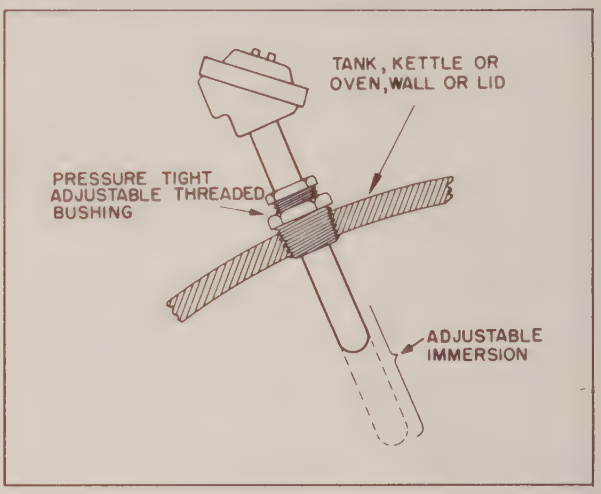

FIG. 10. TANK, KETTLE, PIPE OR OVEN WITH THERMOCOUPLE MOUNTED WITH A PRESSURE AND GAS TIGHT ADJUSTABLE THREADED BUSHING.

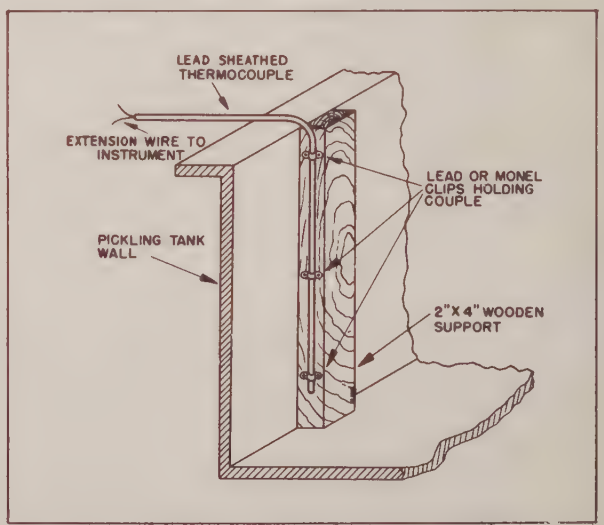

FIG. 11. PICKLING, PLATING OR ACID TANK SHOWING SUGGESTED MEANS OF MOUNTING LEAD SHEATHED REPARABLE THERMOCOUPLE.

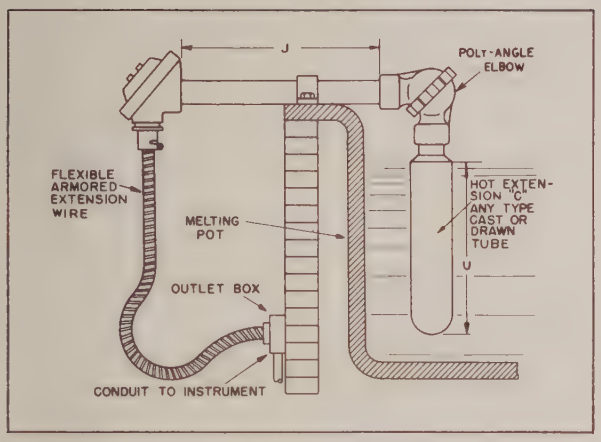

FIG. 12. POT OR KETTLE FOR ALUMINUM, DIECAST METAL, STEREOTYPE, GALVANIZING, MOLTEN SALT BATHS WITH ANGLE TYPE COUPLE. FLEXIBLE ARMORED EXTENSION WIRE PERMITS REMOVAL OF COUPLE FOR CHARGING POT, COUPLE INSPECTION AND WHITEWASHING OF WELL.

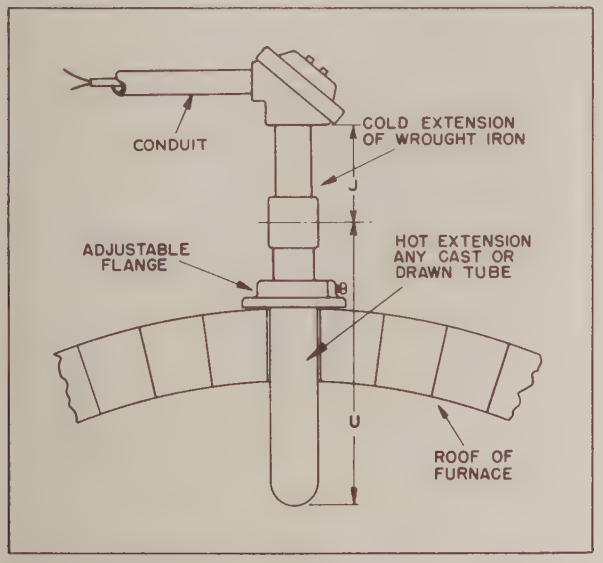

FIG. 13. MUFFLE, HEAT TREATING OR HARDENING FURNACE WITH HOT AND COLD EXTENSION TYPE COUPLE MOUNTED WITH AN ADJUSTABLE FLANGE.

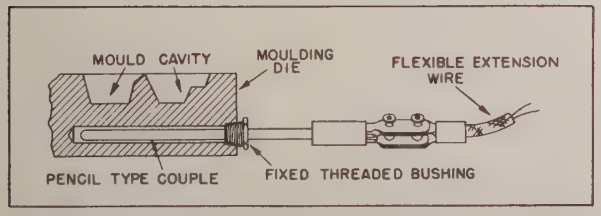

FIG. 16. MOULDING TEMPERATURES OF DIES IN PLATEN PRESS PLASTIC MOULDING TAKEN WITH PENCIL TYPE COUPLE MOUNTED WITH FIXED THREADED BUSHING.

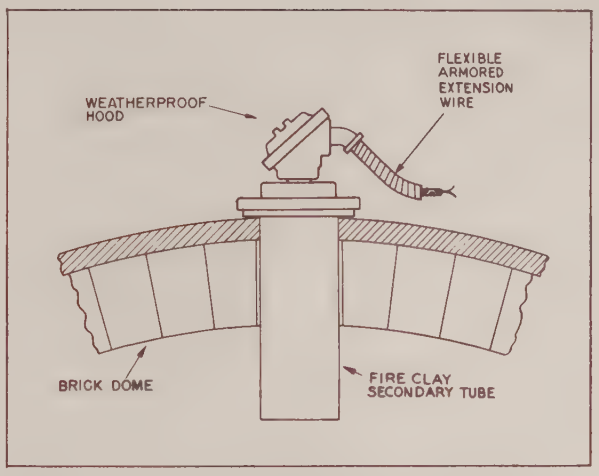

FIG. 14. BRICK, PORCELAIN, TILE, KILN, ETC., ROOF OR DOME WITH PLATINUM COUPLE WITH HEAD SUITABLE FOR OUT DOOR INSTALLATION.

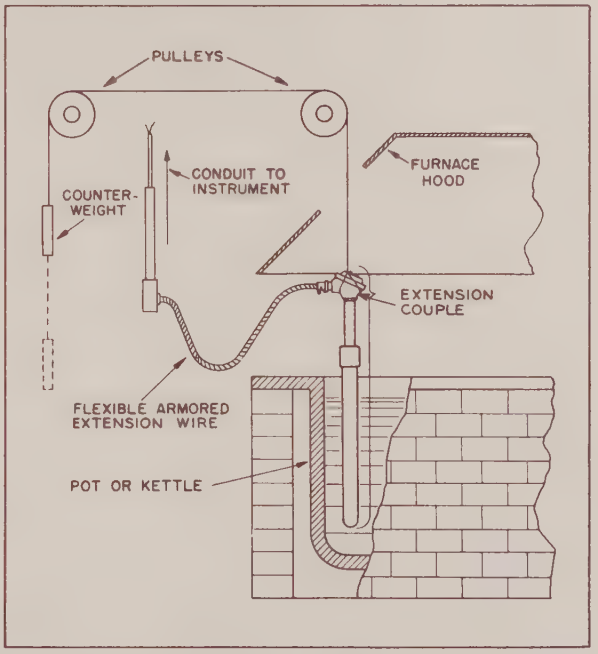

FIG. 15. ALUMINUM, DIECASTING, GALVANIZING, ETC., KETTLE OR POT, WITH HOT & COLD EXTENSION TYPE COUPLE SUSPENDED BY PULLEYS AND COUNTER-WEIGHT, PERMITTING CONVENIENT WITHDRAWAL BETWEEN MELTS, FOR WHITEWASHING, INSPECTION, ETC.

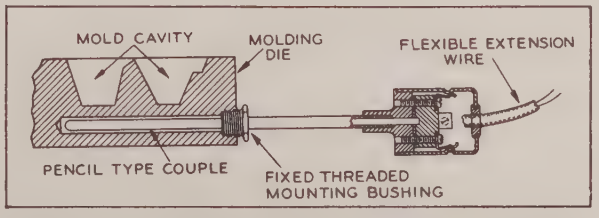

FIG. 17. MOULDING TEMPERATURES OF DIES IN PLATEN PRESS PLASTIC MOULDING TAKEN WITH PENCIL TYPE COUPLE MOUNTED WITH FIXED THREADED BUSHING.

Instruction No. P12514
Issued May 1964

INSTRUCTION NO. P12514

THERMOCOUPLE CALIBRATION DATA

Note: These data are based on the tables of NBS Research Paper 2415 and NBS Circular 508, as adopted by the Scientific Apparatus Makers Association and the Instrument Society of America.

	Page
Iron-Constantan Thermocouples, Type J	2
Copper-Constantan Thermocouples, Type T	3
Chromel-Alumel Thermocouples, Type K (25H)	4, 5
Platinum-Platinum, 10% Rhodium Thermocouples, Type S	6, 7
Platinum-Platinum, 13% Rhodium Thermocouples, Type R	8, 9
Iron-Constantan Thermocouples, Type Y (RP1080)	10

THE BRISTOL COMPANY WATERBURY 20, CONNECTICUT

°F

IRON-CONSTANTAN THERMOCOUPLES

Degrees Fahrenheit (Int. 1948) Cold End at 75° F (EMF at 32° F = −1.22 mv)

EMF IN ABSOLUTE MILLIVOLTS

°F.	0	−5	−10	−15	−20	−25	−30	−35	−40	−45	−50	−55	−60	−65	−70	−75	−80	−85	−90	−95	°F.
−300	−8.74	−8 81	−8.88	−8.95	−9.01																−300
−200	−6.98	−7.08	−7.18	−7.28	−7.38	−7.47	−7.57	−7.66	−7.75	−7.84	−7.93	−8.02	−8.11	−8.19	−8.28	−8.36	−8.44	−8.52	−8.60	−8.67	−200
−100	−4.71	−4.83	−4.95	−5.07	−5.19	−5.31	−5.43	−5.55	−5.66	−5.78	−5.90	−6.01	−6.12	−6.23	−6.34	−6.45	−6.56	−6.66	−6.77	−6.87	−100
0	−2.11	−2.24	−2.38	−2.51	−2.65	−2.78	−2.92	−3.05	−3.18	−3.31	−3.44	−3.57	−3.70	−3.83	−3.96	−4.08	−4.21	−4.34	−4.46	−4.58	0
°F.	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	°F.
0	−2.11	−1.97	−1.83	−1.70	−1.56	−1.42	−1.28	−1.14	−1.00	−0.86	−0.72	−0.57	−0.43	−0.29	−0.15	0.00	0.14	0.29	0.43	0.58	0
100	0.72	0.87	1.01	1.16	1.30	1.45	1.60	1.75	1.89	2.04	2.19	2.34	2.49	2.64	2.79	2.94	3.09	3.24	3.39	3.54	100
200	3.69	3.84	3.99	4.14	4.29	4.44	4.59	4.74	4.89	5.05	5.20	5.35	5.50	5.65	5.81	5.96	6.11	6.26	6.42	6.57	200
300	6.72	6.88	7.03	7.18	7.34	7.49	7.65	7.80	7.95	8.11	8.26	8.42	8.57	8.73	8.88	9.03	9.19	9.34	9.50	9.65	300
400	9.81	9.96	10.12	10.27	10.43	10.58	10.74	10.89	11.04	11.20	11.35	11.51	11.66	11.82	11.97	12.12	12.28	12.43	12.59	12.74	400
500	12.90	13.05	13.20	13.36	13.51	13.66	13.82	13.97	14.12	14.28	14.43	14.58	14.74	14.89	15.04	15.20	15.35	15.50	15.66	15.81	500
600	15.96	16.12	16.27	16.42	16.58	16.73	16.89	17.04	17.19	17.35	17.50	17.65	17.81	17.96	18.12	18.27	18.42	18.58	18.73	18.88	600
700	19.04	19.19	19.34	19.50	19.65	19.80	19.96	20.11	20.26	20.42	20.57	20.72	20.88	21.03	21.18	21.33	21.49	21.64	21.79	21.95	700
800	22.10	22.25	22.41	22.56	22.71	22.87	23.02	23.17	23.33	23.48	23.63	23.79	23.94	24.10	24.25	24.40	24.56	24.71	24.87	25.02	800
900	25.18	25.33	25.48	25.64	25.80	25.95	26.11	26.26	26.42	26.58	26.73	26.89	27.04	27.20	27.36	27.52	27.67	27.83	27.99	28.15	900
1000	28.30	28.46	28.62	28.78	28.94	29.10	29.26	29.42	29.58	29.74	29.90	30.06	30.22	30.38	30.54	30.70	30.86	31.02	31.18	31.34	1000
1100	31.50	31.67	31.83	31.99	32.15	32.32	32.48	32.64	32.81	32.97	33.14	33.30	33.46	33.63	33.79	33.96	34.13	34.29	34.46	34.62	1100
1200	34.79	34.96	35.13	35.30	35.47	35.64	35.80	35.98	36.14	36.32	36.49	36.66	36.83	37.00	37.17	37.35	37.52	37.69	37.86	38.04	1200
1300	38.21	38.39	38.56	38.74	38.91	39.09	39.26	39.44	39.61	39.79	39.97	40.14	40.32	40.50	40.68	40.85	41.03	41.21	41.39	41.56	1300
1400	41.74	41.92	42.10	42.28	42.46	42.63	42.81	42.99	43.17	43.35	43.53	43.71	43.88	44.06	44.24	44.42	44.60	44.78	44.96	45.13	1400
1500	45.31	45.49	45.67	45.85	46.02	46.20	46.38	46.56	46.73	46.91	47.09	47.26	47.44	47.61	47.79	47.96	48.14	48.31	48.48	48.66	1500
1600	48.83																				1600

°C

IRON-CONSTANTAN THERMOCOUPLES

Degrees Celsius (Centigrade, Int. 1948) Cold End at 25° C (EMF at 0° C = −1.28 mv)

EMF IN ABSOLUTE MILLIVOLTS

°C.	0	−5	−10	−15	−20	−25	−30	−35	−40	−45	−50	−55	−60	−65	−70	−75	−80	−85	−90	−95	°C.
−100	−5.91	−6.11	−6.31	−6.51	−6.70	−6.89	−7.08	−7.26	−7.44	−7.61	−7.78	−7.94	−8.10	−8.25	−8.40	−8.55	−8.68	−8.82	−8.94	−9.06	−100
0	−1.28	−1.53	−1.78	−2.03	−2.28	−2.52	−2.76	−3.00	−3.24	−3.48	−3.71	−3.94	−4.17	−4.40	−4.62	−4 84	−5.06	−5.28	−5.49	−5.70	0
°C.	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	°C.
0	−1.28	−1.03	−0.78	−0.52	−0.26	0.00	0.26	0.52	0.78	1.04	1.30	1.57	1.83	2.10	2.37	2.64	2.91	3.18	3.45	3.72	0
100	3.99	4.26	4.53	4.80	5.08	5.35	5.62	5.90	6.17	6.45	6.72	7.00	7.28	7.56	7.83	8.11	8.39	8.67	8.94	9.22	100
200	9.50	9.78	10.06	10.34	10.61	10.89	11.17	11.45	11.73	12.00	12.28	12.56	12.84	13.11	13.39	13.66	13.94	14.22	14.49	14.77	200
300	15.05	15.32	15.60	15.87	16.15	16.43	16.70	16.98	17.26	17.53	17.81	18.09	18.36	18.64	18.92	19.19	19.47	19.74	20.02	20.29	300
400	20.57	20 85	21.12	21.40	21.67	21.95	22.22	22.50	22.78	23.05	23.33	23.60	23.88	24.16	24.44	24.71	24.99	25.27	25.55	25.83	400
500	26.11	26.39	26.67	26.95	27.24	27.52	27.80	28.09	28.37	28.66	28.94	29.23	29.52	29.80	30.09	30.38	30.67	30.96	31.25	31.54	500
600	31.83	32.13	32.42	32.71	33.01	33.30	33.60	33.90	34.20	34.50	34.80	35.10	35.41	35.71	36.02	36.32	36.63	36.94	37.25	37.56	600
700	37.87	38.19	38.50	38.82	39.13	39.45	39.77	40.08	40.40	40.72	41.04	41.36	41.68	42.00	42.32	42.64	42.97	43.29	43.61	43.93	700
800	44.25	44.57	44.90	45.22	45.54	45.86	46.18	46.50	46.81	47.13	47.45	47.76	48.08	48.39	48.70						800

T (24B) °F

COPPER-CONSTANTAN THERMOCOUPLES

Degrees Fahrenheit (Int. 1948) Cold End at 75° F (EMF at 32° F = –0.944 mv)

EMF IN ABSOLUTE MILLIVOLTS																				
°F.	0	–5	–10	–15	–20	–25	–30	–35	–40	–45	–50	–55	–60	–65	–70	–75	–80	–85	–90	–95	°F.
–300	–6.228	–6.276	–6.323																		–300
–200	–5.055	–5.123	–5.190	–5.256	–5.321	–5.385	–5.448	–5.510	–5.571	–5.632	–5.691	–5.749	–5.807	–5.863	–5.918	–5.973	–6.025	–6.078	–6.129	–6.179	–200
–100	–3.503	–3.589	–3.674	–3.758	–3.841	–3.924	–4.006	–4.087	–4.167	–4.245	–4.324	–4.401	–4.477	–4.553	–4.628	–4.701	–4.773	–4.845	–4.916	–4.986	–100
0	–1.614	–1.715	–1.816	–1.917	–2.016	–2.115	–2.214	–2.311	–2.407	–2.503	–2.598	–2.692	–2.786	–2.878	–2.970	–3.061	–3.151	–3.240	–3.329	–3.416	– 0
°F.	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	°F.
0	–1.614	–1.511	–1.407	–1.303	–1.198	–1.093	–0.986	–0.880	–0.773	–0.664	–0.555	–0.445	–0.335	–0.224	–0.112	0.000	0.113	0.227	0.342	0.457	0
100	0.573	0.689	0.807	0.925	1.043	1.163	1.282	1.402	1.523	1.645	1.767	1.891	2.014	2.138	2.263	2.388	2.514	2.640	2.768	2.895	100
200	3.023	3.152	3.281	3.411	3.542	3.673	3.805	3.936	4.070	4.203	4.336	4.471	4.606	4.741	4.877	5.013	5.150	5.288	5.426	5.564	200
300	5.703	5.842	5.982	6.122	6.264	6.405	6.547	6.689	6.832	6.976	7.120	7.263	7.408	7.553	7.698	7.844	7.991	8.138	8.285	8.432	300
400	8.581	8.730	8.879	9.029	9.179	9.329	9.479	9.630	9.782	9.934	10.086	10.239	10.392	10.546	10.699	10.853	11.009	11.164	11.319	11.474	400
500	11.631	11.788	11.944	12.102	12.259	12.418	12.576	12.734	12.894	13.053	13.213	13.373	13.533	13.693	13.855	14.017	14.178	14.340	14.503	14.666	500
600	14.829	14.993	15.157	15.320	15.485	15.649	15.814	15.980	16.145	16.311	16.477	16.644	16.810	16.977	17.145	17.313	17.481	17.649	17.817	17.986	600
700	18.156	18.325	18.495	18.664	18.835	19.005	19.176	19.347	19.519	19.690	19.861										700

T (24B) °C

COPPER-CONSTANTAN THERMOCOUPLES

Degrees Celsius (Centigrade, Int. 1948) Cold End at 25° C (EMF at 0° C = –0.990 mv)

EMF IN ABSOLUTE MILLIVOLTS																				
°C.	0	–5	–10	–15	–20	–25	–30	–35	–40	–45	–50	–55	–60	–65	–70	–75	–80	–85	–90	–95	°C.
–100	–4.339	–4.478	–4.614	–4.747	–4.877	–5.004	–5.128	–5.249	–5.367	–5.482	–5.593	–5.702	–5.807	–5.909	–6.008	–6.103	–6.195	–6.284	–6.369		–100
0	–0.990	–1.181	–1.370	–1.557	–1.741	–1.923	–2.102	–2.279	–2.453	–2.625	–2.794	–2.961	–3.125	–3.286	–3.445	–3.601	–3.754	–3.904	–4.052	–4.197	0
°C.	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	°C.
0	–0.990	–0.797	–0.601	–0.403	–0.203	0.000	0.204	0.411	0.620	0.831	1.045	1.260	1.477	1.697	1.918	2.142	2.367	2.594	2.823	3.054	0
100	3.287	3.522	3.759	3.997	4.237	4.479	4.722	4.967	5.214	5.463	5.713	5.964	6.218	6.472	6.729	6.988	7.246	7.507	7.769	8.033	100
200	8.298	8.565	8.833	9.103	9.373	9.645	9.919	10.193	10.469	10.745	11.025	11.304	11.585	11.867	12.150	12.435	12.720	13.007	13.295	13.583	200
300	13.874	14.165	14.457	14.750	15.045	15.340	15.636	15.934	16.232	16.531	16.831	17.133	17.435	17.737	18.042	18.347	18.652	18.959	19.267	19.575	300
400	19.884																				400

(25H) °F

CHROMEL-ALUMEL THERMOCOUPLES

Degrees Fahrenheit (Int. 1948) Cold End at 75° F (EMF at 32° F = –0.95 mv)

EMF IN ABSOLUTE MILLIVOLTS

°F.	0	–5	–10	–15	–20	–25	–30	–35	–40	–45	–50	–55	–60	–65	–70	–75	–80	–85	–90	–95	°F.
																					–300
–300	–6.46	–6.50	–6.55																		
–200	–5.24	–5.31	–5.39	–5.46	–5.53	–5.59	–5.66	–5.72	–5.79	–5.85	–5.91	–5.97	–6.03	–6.09	–6.15	–6.20	–6.25	–6.31	–6.36	–6.41	–200
–100	–3.60	–3.69	–3.78	–3.87	–3.96	–4.05	–4.14	–4.22	–4.31	–4.39	–4.47	–4.55	–4.64	–4.71	–4.79	–4.87	–4.95	–5.02	–5.10	–5.17	–100
0	–1.63	–1.74	–1.84	–1.94	–2.05	–2.15	–2.25	–2.35	–2.45	–2.55	–2.65	–2.75	–2.85	–2.94	–3.04	–3.13	–3.23	–3.32	–3.42	–3.51	0
°F.	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	°F.
0	–1.63	–1.53	–1.42	–1.32	–1.21	–1.10	–0.99	–0.88	–0.77	–0.66	–0.55	–0.44	–0.33	–0.22	–0.11	0.00	0.11	0.23	0.34	0.45	0
100	0.57	0.68	0.79	0.91	1.02	1.14	1.25	1.37	1.48	1.60	1.71	1.83	1.94	2.06	2.17	2.29	2.41	2.52	2.64	2.75	100
200	2.87	2.99	3.10	3.22	3.33	3.45	3.56	3.68	3.79	3.91	4.02	4.13	4.25	4.36	4.47	4.58	4.70	4.81	4.92	5.03	200
300	5.14	5.25	5.36	5.47	5.58	5.70	5.81	5.92	6.03	6.14	6.25	6.36	6.47	6.58	6.69	6.80	6.92	7.03	7.14	7.25	300
400	7.36	7.47	7.59	7.70	7.81	7.92	8.03	8.14	8.26	8.37	8.48	8.59	8.71	8.82	8.93	9.05	9.16	9.27	9.39	9.50	400
500	9.62	9.73	9.84	9.96	10.07	10.18	10.30	10.41	10.53	10.64	10.76	10.87	10.99	11.10	11.22	11.33	11.45	11.56	11.68	11.79	500
600	11.91	12.02	12.14	12.25	12.37	12.49	12.60	12.72	12.83	12.95	13.07	13.18	13.30	13.41	13.53	13.65	13.76	13.88	14.00	14.11	600
700	14.23	14.35	14.46	14.58	14.70	14.81	14.93	15.05	15.17	15.28	15.40	15.52	15.64	15.75	15.87	15.99	16.11	16.22	16.34	16.46	700
800	16.58	16.69	16.81	16.93	17.05	17.16	17.28	17.40	17.52	17.63	17.75	17.87	17.99	18.11	18.23	18.34	18.46	18.58	18.70	18.82	800
900	18.94	19.06	19.18	19.29	19.41	19.53	19.65	19.77	19.89	20.00	20.12	20.24	20.36	20.48	20.59	20.71	20.83	20.95	21.07	21.19	900
1000	21.31	21.42	21.54	21.66	21.78	21.90	22.02	22.13	22.25	22.37	22.49	22.61	22.73	22.85	22.96	23.08	23.20	23.32	23.44	23.56	1000
1100	23.68	23.79	23.91	24.03	24.15	24.27	24.39	24.51	24.62	24.74	24.86	24.98	25.10	25.21	25.33	25.45	25.57	25.68	25.80	25.92	1100
1200	26.03	26.15	26.27	26.39	26.50	26.62	26.74	26.85	26.97	27.09	27.20	27.32	27.44	27.55	27.67	27.79	27.91	28.02	28.14	28.26	1200
1300	28.37	28.49	28.61	28.72	28.84	28.96	29.07	29.19	29.30	29.42	29.54	29.65	29.77	29.88	30.00	30.12	30.23	30.35	30.47	30.58	1300
1400	30.70	30.81	30.93	31.04	31.16	31.27	31.39	31.50	31.62	31.73	31.85	31.96	32.07	32.19	32.30	32.42	32.53	32.64	32.76	32.87	1400
1500	32.98	33.10	33.21	33.33	33.44	33.55	33.67	33.78	33.89	34.01	34.12	34.23	34.34	34.46	34.57	34.68	34.80	34.91	35.02	35.13	1500
1600	35.24	35.36	35.47	35.58	35.69	35.81	35.92	36.03	36.14	36.25	36.36	36.48	36.59	36.70	36.81	36.92	37.03	37.14	37.25	37.37	1600
1700	37.48	37.59	37.70	37.81	37.92	38.03	38.14	38.25	38.36	38.47	38.58	38.69	38.80	38.91	39.01	39.12	39.23	39.34	39.45	39.56	1700
1800	39.67	39.78	39.89	40.00	40.10	40.21	40.32	40.43	40.54	40.65	40.75	40.86	40.97	41.08	41.19	41.29	41.40	41.51	41.62	41.72	1800
1900	41.83	41.94	42.04	42.15	42.26	42.36	42.47	42.58	42.68	42.79	42.90	43.00	43.11	43.22	43.32	43.43	43.54	43.64	43.75	43.85	1900
2000	43.96	44.06	44.17	44.27	44.38	44.48	44.59	44.69	44.80	44.90	45.01	45.11	45.22	45.32	45.43	45.53	45.63	45.74	45.84	45.95	2000
2100	46.05	46.15	46.26	46.36	46.46	46.57	46.67	46.77	46.87	46.98	47.08	47.18	47.28	47.39	47.49	47.59	47.69	47.79	47.90	48.00	2100
2200	48.10	48.20	48.30	48.40	48.50	48.60	48.70	48.81	48.91	49.01	49.11	49.21	49.31	49.41	49.51	49.61	49.70	49.80	49.90	50.00	2200
2300	50.10	50.20	50.30	50.40	50.50	50.59	50.69	50.79	50.89	50.99	51.08	51.18	51.28	51.38	51.47	51.57	51.67	51.77	51.86	51.96	2300
2400	52.06	52.15	52.25	52.35	52.44	52 54	52.64	52.73	52.83	52.92	53.02	53.11	53.21	53.30	53.40	53.49	53.59	53.68	53.78	53.87	2400
2500	53.97	54.07	54.16	54.26	54.35	54.45	54.54	54.64	54.73	54.83	54.92	55.02	55.11	55.21	55.30	55.40	55.49	55.59	55.68	55.78	2500
2600	55.87	55.97	56.06	56.16	56.25	56.35	56.44	56.54	56.63	56.73	56.82										2600

K (25H) °C

CHROMEL-ALUMEL THERMOCOUPLES

Degrees Celsius (Centigrade, Int. 1948) Cold End at 25° C (EMF at 0° C = −1.00 mv)

EMF IN ABSOLUTE MILLIVOLTS

°C.	0	−5	−10	−15	−20	−25	−30	−35	−40	−45	−50	−55	−60	−65	−70	−75	−80	−85	−90	−95	°C.
−200	−6.75																				−200
−100	−4.49	−4.64	−4.78	−4.92	−5.06	−5.19	−5.32	−5.45	−5.58	−5.70	−5.81	−5.92	−6.03	−6.14	−6.24	−6.34	−6.43	−6.52	−6.60	−6.68	−100
0	−1.00	−1.19	−1.39	−1.58	−1.77	−1.95	−2.14	−2.32	−2.50	−2.68	−2.86	−3.03	−3.20	−3.37	−3.54	−3.71	−3.87	−4.03	−4.19	−4.34	0
°C.	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	°C.
0	−1.00	−0.80	−0.60	−0.40	−0.20	0.00	0.20	0.40	0.61	0.81	1.02	1.23	1.43	1.64	1.85	2.05	2.26	2.47	2.68	2.89	0
100	3.10	3.31	3.51	3.72	3.92	4.13	4.33	4.53	4.73	4.93	5.13	5.33	5.53	5.73	5.93	6.13	6.33	6.53	6.73	6.93	100
200	7.13	7.33	7.54	7.74	7.94	8.14	8.34	8.54	8.75	8.95	9.16	9.36	9.57	9.77	9.98	10.18	10.39	10.59	10.80	11.01	200
300	11.21	11.42	11.63	11.83	12.04	12.25	12.46	12.67	12.88	13.09	13.29	13.50	13.71	13.92	14.13	14.34	14.55	14.76	14.98	15.19	300
400	15.40	15.61	15.82	16.03	16.24	16.46	16.67	16.88	17.09	17.30	17.51	17.73	17.94	18.15	18.36	18.58	18.79	19.01	19.22	19.43	400
500	19.65	19.86	20.07	20.28	20.50	20.71	20.92	21.14	21.35	21.56	21.78	21.99	22.20	22.42	22.63	22.84	23.06	23.27	23.49	23.70	500
600	23.91	24.12	24.34	24.55	24.76	24.98	25.19	25.40	25.61	25.82	26.03	26.24	26.45	26.66	26.87	27.08	27.29	27.50	27.72	27.93	600
700	28.14	28.35	28.56	28.77	28.97	29.18	29.39	29.60	29.81	30.02	30.23	30.44	30.65	30.85	31.06	31.27	31.48	31.68	31.89	32.09	700
800	32.30	32.50	32.71	32.91	33.12	33.32	33.53	33.73	33.93	34.14	34.34	34.54	34.75	34.95	35.15	35.35	35.55	35.76	35.96	36.16	800
900	36.36	36.56	36.76	36.96	37.16	37.36	37.56	37.76	37.95	38.15	38.35	38.55	38.75	38.94	39.14	39.34	39.53	39.73	39.92	40.12	900
1000	40.31	40.51	40.70	40.90	41.09	41.29	41.48	41.67	41.87	42.06	42.25	42.44	42.63	42.83	43.02	43.21	43.40	43.59	43.78	43.97	1000
1100	44.16	44.35	44.54	44.73	44.92	45.11	45.29	45.48	45.67	45.85	46.04	46.23	46.41	46.60	46.78	46.97	47.15	47.34	47.52	47.70	1100
1200	47.89	48.07	48.25	48.43	48.62	48.80	48.98	49.16	49.34	49.52	49.69	49.87	50.05	50.23	50.41	50.58	50.76	50.94	51.11	51.29	1200
1300	51.46	51.64	51.81	51.99	52.16	52.34	52.51	52.68	52.85	53.03	53.20	53.37	53.54	53.71	53.88						1300

S °F

PLATINUM-PLATINUM, 10% RHODIUM THERMOCOUPLES

Degrees Fahrenheit (Int. 1948) Cold End at 75° F (EMF at 32° F = –0.136 mv)

EMF IN ABSOLUTE MILLIVOLTS

°F.	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	°F.
0	–0.236	–0.220	–0.205	–0.189	–0.173	–0.158	–0.142	–0.127	–0.112	–0.096	–0.080	–0.065	–0.049	–0.032	–0.016	0.000	0.017	0.034	0.051	0.068	0
100	0.085	0.102	0.120	0.138	0.155	0.173	0.191	0.210	0.228	0.247	0.265	0.284	0.303	0.322	0.341	0.360	0.380	0.399	0.419	0.439	100
200	0.459	0.479	0.499	0.519	0.540	0.560	0.581	0.602	0.622	0.643	0.664	0.686	0.707	0.728	0.750	0.771	0.793	0.815	0.837	0.858	200
300	0.881	0.903	0.925	0.947	0.970	0.992	1.015	1.037	1.060	1.083	1.106	1.128	1.151	1.175	1.198	1.221	1.244	1.268	1.291	1.314	300
400	1.338	1.362	1.385	1.409	1.433	1.457	1.480	1.504	1.528	1.552	1.576	1.600	1.625	1.649	1.673	1.697	1.722	1.746	1.771	1.795	400
500	1.820	1.845	1.869	1.894	1.919	1.944	1.969	1.994	2.019	2.044	2.069	2.094	2.119	2.145	2.170	2.195	2.221	2.246	2.271	2.297	500
600	2.322	2.348	2.374	2.399	2.425	2.451	2.477	2.502	2.528	2.554	2.580	2.606	2.632	2.658	2.684	2.710	2.736	2.762	2.788	2.815	600
700	2.841	2.867	2.893	2.920	2.946	2.972	2.999	3.025	3.052	3.078	3.104	3.131	3.157	3.184	3.211	3.237	3.264	3.290	3.317	3.344	700
800	3.370	3.397	3.424	3.451	3.478	3.504	3.531	3.558	3.585	3.612	3.639	3.666	3.693	3.720	3.747	3.774	3.801	3.828	3.855	3.883	800
900	3.910	3.937	3.964	3.992	4.019	4.046	4.074	4.101	4.128	4.156	4.183	4.211	4.238	4.266	4.294	4.321	4.349	4.376	4.404	4.432	900
1000	4.460	4.487	4.515	4.543	4.571	4.599	4.627	4.654	4.682	4.710	4.738	4.766	4.794	4.823	4.851	4.879	4.907	4.935	4.963	4.992	1000
1100	5.020	5.048	5.076	5.105	5.133	5.162	5.190	5.218	5.247	5.275	5.304	5.333	5.361	5.390	5.419	5.447	5.476	5.504	5.533	5.562	1100
1200	5.590	5.619	5.648	5.677	5.706	5.735	5.763	5.792	5.821	5.850	5.879	5.908	5.937	5.966	5.995	6.025	6.054	6.083	6.112	6.141	1200
1300	6.171	6.200	6.229	6.258	6.288	6.317	6.347	6.376	6.406	6.435	6.465	6.494	6.524	6.553	6.583	6.613	6.642	6.672	6.702	6.731	1300
1400	6.761	6.791	6.821	6.851	6.881	6.910	6.940	6.970	7.000	7.030	7.060	7.090	7.121	7.151	7.181	7.211	7.241	7.271	7.302	7.332	1400
1500	7.362	7.393	7.423	7.453	7.484	7.514	7.545	7.575	7.606	7.636	7.667	7.698	7.728	7.759	7.789	7.820	7.851	7.882	7.912	7.943	1500
1600	7.974	8.005	8.036	8.067	8.098	8.129	8.160	8.191	8.222	8.253	8.284	8.315	8.346	8.377	8.409	8.440	8.471	8.502	8.534	8.565	1600
1700	8.596	8.628	8.659	8.691	8.722	8.754	8.785	8.817	8.848	8.880	8.912	8.943	8.975	9.007	9.038	9.070	9.102	9.134	9.166	9.197	1700
1800	9.229	9.261	9.293	9.325	9.357	9.389	9.421	9.453	9.485	9.518	9.550	9.582	9.614	9.646	9.679	9.711	9.743	9.776	9.808	9.840	1800
1900	9.873	9.905	9.938	9.970	10.003	10.035	10.068	10.101	10.133	10.166	10.198	10.231	10.264	10.297	10.329	10.362	10.395	10.428	10.461	10.493	1900
2000	10.526	10.559	10.592	10.625	10.658	10.691	10.724	10.757	10.790	10.823	10.856	10.889	10.922	10.955	10.988	11.021	11.054	11.088	11.121	11.154	2000
2100	11.187	11.220	11.253	11.287	11.320	11.353	11.386	11.420	11.453	11.486	11.519	11.553	11.586	11.619	11.653	11.686	11.719	11.752	11.786	11.819	2100
2200	11.853	11.886	11.919	11.953	11.986	12.019	12.053	12.086	12.120	12.153	12.186	12.220	12.253	12.287	12.320	12.354	12.387	12.420	12.454	12.487	2200
2300	12.521	12.554	12.588	12.621	12.654	12.688	12.721	12.755	12.788	12.821	12.855	12.888	12.922	12.955	12.988	13.022	13.055	13.088	13.122	13.155	2300
2400	13.189	13.222	13.255	13.289	13.322	13.355	13.389	13.422	13.455	13.489	13.522	13.555	13.589	13.622	13.655	13.689	13.722	13.755	13.788	13.822	2400
2500	13.855	13.888	13.922	13.955	13.988	14.021	14.055	14.088	14.121	14.154	14.188	14.221	14.254	14.287	14.321	14.354	14.387	14.420	14.453	14.487	2500
2600	14.520	14.553	14.586	14.619	14.653	14.686	14.719	14.752	14.785	14.818	14.852	14.885	14.918	14.951	14.984	15.017	15.050	15.083	15.117	15.150	2600
2700	15.183	15.216	15.249	15.282	15.315	15.348	15.381	15.414	15.447	15.480	15.513	15.546	15.579	15.612	15.645	15.678	15.711	15.744	15.777	15.810	2700
2800	15.843	15.876	15.909	15.942	15.975	16.008	16.041	16.074	16.107	16.139	16.172	16.205	16.238	16.271	16.304	16.337	16.370	16.402	16.435	16.468	2800
2900	16.501	16.534	16.566	16.599	16.632	16.665	16.698	16.730	16.763	16.796	16.829	16.861	16.894	16.927	16.959	16.992	17.025	17.058	17.090	17.123	2900
3000	17.156	17.188	17.221	17.253	17.286	17.319	17.351	17.384	17.416	17.449	17.482	17.514	17.547	17.579	17.612	17.644	17.677	17.709	17.742	17.774	3000
3100	17.807	17.839	17.872	17.904	17.937	17.969	18.001	18.034	18.066	18.099	18.131	18.163	18.196	18.228	18.260	18.293	18.325	18.357	18.390	18.422	3100
3200	18.454	18.486	18.519	18.551																	3200

S °C

PLATINUM-PLATINUM, 10% RHODIUM THERMOCOUPLES

Degrees Celsius (Centigrade, Int. 1948) Cold End at 25° C(EMF at 0°C = –0.143 mv)

EMF IN ABSOLUTE MILLIVOLTS

°C.	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	°C.
0	–0.143	–0.115	–0.087	–0.059	–0.030	0.000	0.030	0.061	0.092	0.123	0.156	0.188	0.221	0.254	0.288	0.323	0.357	0.392	0.428	0.464	0
100	0.500	0.537	0.574	0.611	0.649	0.687	0.726	0.764	0.803	0.843	0.882	0.922	0.963	1.003	1.044	1.085	1.126	1.168	1.209	1.251	100
200	1.293	1.336	1.378	1.421	1.464	1.507	1.550	1.593	1.637	1.681	1.725	1.769	1.813	1.857	1.902	1.947	1.992	2.037	2.082	2.127	200
300	2.173	2.219	2.264	2.310	2.356	2.403	2.449	2.495	2.542	2.588	2.635	2.682	2.729	2.776	2.823	2.871	2.918	2.965	3.013	3.060	300
400	3.108	3.156	3.204	3.251	3.299	3.347	3.396	3.444	3.492	3.540	3.589	3.637	3.686	3.735	3.783	3.832	3.881	3.930	3.979	4.028	400
500	4.078	4.127	4.176	4.226	4.276	4.325	4.375	4.425	4.475	4.525	4.575	4.625	4.675	4.726	4.776	4.827	4.877	4.928	4.979	5.030	500
600	5.081	5.132	5.183	5.234	5.286	5.337	5.389	5.440	5.492	5.543	5.595	5.647	5.699	5.751	5.803	5.855	5.907	5.959	6.012	6.064	600
700	6.117	6.169	6.222	6.275	6.328	6.381	6.434	6.487	6.540	6.594	6.647	6.701	6.754	6.808	6.862	6.915	6.969	7.023	7.077	7.132	700
800	7.186	7.240	7.295	7.349	7.404	7.459	7.513	7.568	7.623	7.678	7.733	7.789	7.844	7.899	7.955	8.010	8.066	8.122	8.177	8.233	800
900	8.289	8.345	8.402	8.458	8.514	8.571	8.627	8.684	8.740	8.797	8.854	8.911	8.968	9.025	9.082	9.139	9.197	9.254	9.312	9.369	900
1000	9.427	9.485	9.543	9.601	9.659	9.717	9.775	9.833	9.892	9.950	10.009	10.067	10.126	10.185	10.244	10.303	10.362	10.421	10.480	10.539	1000
1100	10.598	10.658	10.717	10.776	10.836	10.895	10.955	11.014	11.074	11.134	11.193	11.253	11.313	11.373	11.432	11.492	11.552	11.612	11.672	11.732	1100
1200	11.792	11.852	11.912	11.972	12.032	12.093	12.153	12.213	12.273	12.333	12.393	12.454	12.514	12.574	12.634	12.694	12.754	12.814	12.875	12.935	1200
1300	12.995	13.055	13.115	13.175	13.235	13.295	13.355	13.415	13.475	13.535	13.595	13.655	13.715	13.775	13.835	13.895	13.955	14.014	14.074	14.134	1300
1400	14.194	14.254	14.314	14.373	14.433	14.493	14.553	14.612	14.672	14.732	14.792	14.851	14.911	14.970	15.030	15.090	15.149	15.209	15.268	15.328	1400
1500	15.387	15.447	15.506	15.566	15.625	15.684	15.744	15.803	15.863	15.922	15.981	16.040	16.100	16.159	16.218	16.277	16.336	16.395	16.454	16.514	1500
1600	16.573	16.632	16.691	16.750	16.809	16.867	16.926	16.985	17.044	17.103	17.162	17.220	17.279	17.338	17.396	17.455	17.514	17.572	17.631	17.689	1600
1700	17.748	17.806	17.865	17.923	17.981	18.040	18.098	18.156	18.215	18.273	18.331	18.389	18.447	18.505							1700

PLATINUM-PLATINUM, 13% RHODIUM THERMOCOUPLES

Degrees Fahrenheit (Int. 1948) Cold End at 75° F (EMF at 32° F = –0.135 mv)

EMF IN ABSOLUTE MILLIVOLTS

°F.	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	°F.
0	–0.235	–0.220	–0.204	–0.188	–0.173	–0.157	–0.141	–0.126	–0.111	–0.096	–0.080	–0.064	–0.049	–0.032	–0.016	0.000	0.017	0.034	0.051	0.068	0
100	0.085	0.102	0.120	0.137	0.156	0.173	0.192	0.210	0.228	0.246	0.265	0.284	0.303	0.322	0.341	0.361	0.381	0.401	0.421	0.441	100
200	0.461	0.481	0.502	0.522	0.543	0.565	0.586	0.607	0.628	0.650	0.672	0.693	0.715	0.737	0.759	0.782	0.804	0.827	0.849	0.872	200
300	0.895	0.917	0.940	0.963	0.986	1.009	1.032	1.056	1.079	1.103	1.126	1.150	1.174	1.198	1.222	1.246	1.271	1.295	1.320	1.345	300
400	1.369	1.394	1.418	1.443	1.468	1.493	1.518	1.543	1.568	1.594	1.619	1.644	1.670	1.696	1.721	1.747	1.773	1.799	1.825	1.851	400
500	1.877	1.903	1.930	1.956	1.982	2.009	2.035	2.062	2.088	2.115	2.142	2.168	2.195	2.222	2.249	2.277	2.303	2.331	2.358	2.385	500
600	2.412	2.440	2.467	2.495	2.522	2.550	2.577	2.605	2.633	2.661	2.688	2.716	2.744	2.772	2.800	2.828	2.856	2.884	2.912	2.940	600
700	2.968	2.997	3.025	3.053	3.082	3.110	3.138	3.167	3.195	3.224	3.252	3.281	3.310	3.338	3.367	3.396	3.425	3.454	3.483	3.512	700
800	3.542	3.571	3.600	3.629	3.659	3.688	3.717	3.747	3.776	3.806	3.835	3.864	3.894	3.923	3.952	3.981	4.011	4.040	4.070	4.100	800
900	4.129	4.159	4.189	4.219	4.249	4.278	4.308	4.338	4.368	4.398	4.428	4.458	4.489	4.519	4.550	4.580	4.611	4.641	4.672	4.702	900
1000	4.733	4.764	4.795	4.825	4.856	4.887	4.918	4.949	4.980	5.011	5.041	5.073	5.103	5.135	5.166	5.197	5.228	5.259	5.291	5.322	1000
1100	5.353	5.384	5.416	5.447	5.479	5.510	5.542	5.574	5.606	5.638	5.670	5.702	5.734	5.766	5.798	5.829	5.861	5.893	5.925	5.957	1100
1200	5.990	6.021	6.053	6.085	6.117	6.150	6.182	6.214	6.246	6.279	6.311	6.344	6.376	6.409	6.442	6.474	6.507	6.539	6.572	6.605	1200
1300	6.638	6.670	6.703	6.736	6.769	6.802	6.835	6.868	6.902	6.934	6.968	7.001	7.034	7.067	7.100	7.134	7.167	7.201	7.234	7.268	1300
1400	7.301	7.335	7.368	7.402	7.436	7.470	7.504	7.537	7.571	7.605	7.639	7.673	7.707	7.742	7.776	7.810	7.844	7.878	7.912	7.946	1400
1500	7.981	8.015	8.049	8.083	8.118	8.152	8.187	8.221	8.256	8.291	8.325	8.360	8.395	8.430	8.464	8.499	8.534	8.569	8.604	8.639	1500
1600	8.674	8.709	8.744	8.779	8.814	8.849	8.884	8.919	8.955	8.990	9.026	9.061	9.097	9.132	9.168	9.203	9.239	9.274	9.310	9.346	1600
1700	9.381	9.417	9.452	9.488	9.524	9.559	9.595	9.631	9.667	9.703	9.739	9.775	9.811	9.847	9.884	9.921	9.957	9.994	10.029	10.066	1700
1800	10.102	10.139	10.175	10.212	10.248	10.285	10.321	10.358	10.394	10.431	10.468	10.504	10.541	10.577	10.614	10.651	10.688	10.726	10.763	10.801	1800
1900	10.838	10.876	10.913	10.950	10.987	11.025	11.062	11.100	11.138	11.175	11.213	11.250	11.289	11.326	11.364	11.402	11.440	11.478	11.516	11.554	1900
2000	11.591	11.630	11.667	11.705	11.743	11.781	11.819	11.857	11.894	11.933	11.970	12.009	12.047	12.085	12.123	12.161	12.200	12.238	12.276	12.315	2000
2100	12.353	12.391	12.429	12.467	12.506	12.544	12.583	12.621	12.660	12.698	12.736	12.774	12.813	12.851	12.890	12.928	12.967	13.005	13.043	13.081	2100
2200	13.120	13.158	13.197	13.236	13.274	13.313	13.351	13.390	13.429	13.467	13.506	13.544	13.583	13.621	13.660	13.698	13.737	13.776	13.814	13.853	2200
2300	13.892	13.930	13.969	14.007	14.046	14.084	14.123	14.161	14.200	14.239	14.277	14.316	14.355	14.393	14.432	14.471	14.509	14.548	14.586	14.625	2300
2400	14.663	14.702	14.740	14.779	14.817	14.856	14.894	14.933	14.972	15.010	15.049	15.087	15.126	15.164	15.203	15.242	15.280	15.319	15.357	15.396	2400
2500	15.433	15.472	15.510	15.549	15.587	15.626	15.665	15.703	15.742	15.780	15.819	15.857	15.896	15.935	15.973	16.012	16.050	16.089	16.128	16.166	2500
2600	16.205	16.243	16.282	16.320	16.359	16.397	16.436	16.475	16.513	16.552	16.590	16.629	16.667	16.707	16.745	16.783	16.822	16.860	16.898	16.937	2600
2700	16.975	17.013	17.051	17.090	17.128	17.166	17.205	17.243	17.281	17.320	17.358	17.397	17.434	17.473	17.511	17.550	17.588	17.626	17.664	17.702	2700
2800	17.740	17.778	17.816	17.854	17.892	17.930	17.968	18 006	18.044	18.083	18.120	18.159	18.197	18.235	18.273	18.311	18.349	18.387	18.425	18.463	2800
2900	18.501	18.539	18.577	18.615	18.653	18.691	18.729	18.767	18.805	18.843	18.881	18.919	18.957	18.994	19.033	19.070	19.108	19.146	19.183	19.221	2900
3000	19.259	19.297	19.335	19.373	19.410	19.448	19.486	19.524	19.562	19.600	19.638	19.676	19.713	19.751	19.789	19.827	19.864	19.902	19.940	19.977	3000
3100	20.015																				3100

R °C

PLATINUM-PLATINUM, 13% RHODIUM THERMOCOUPLES

Degrees Celsius (Centigrade, Int. 1948) Cold End at 25° C (EMF at 0°C = −0.142 mv)

EMF IN ABSOLUTE MILLIVOLTS																					
°C.	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	°C.
0	−0.142	−0.115	−0.087	−0.059	−0.030	0.000	0.030	0.061	0.092	0.123	0.156	0.188	0.221	0.255	0.289	0.323	0.358	0.394	0.430	0.467	0
100	0.503	0.541	0.579	0.617	0.656	0.695	0.735	0.775	0.815	0.856	0.897	0.938	0.979	1.021	1.063	1.105	1.148	1.191	1.235	1.278	100
200	1.323	1.367	1.411	1.456	1.501	1.546	1.592	1.637	1.684	1.730	1.776	1.823	1.870	1.917	1.965	2.012	2.060	2.108	2.156	2.204	200
300	2.253	2.302	2.351	2.400	2.449	2.499	2.548	2.598	2.648	2.698	2.748	2.798	2.849	2.899	2.950	3.001	3.052	3.103	3.154	3.205	300
400	3.257	3.309	3.360	3.412	3.465	3.517	3.570	3.622	3.675	3.728	3.781	3.834	3.887	3.939	3.992	4.045	4.099	4.152	4.206	4.259	400
500	4.313	4.367	4.421	4.476	4.530	4.585	4.640	4.695	4.751	4.806	4.862	4.917	4.973	5.028	5.084	5.140	5.196	5.252	5.308	5.365	500
600	5.421	5.478	5.535	5.592	5.650	5.707	5.765	5.822	5.880	5.937	5.995	6.052	6.110	6.168	6.226	6.285	6.343	6.402	6.460	6.519	600
700	6.578	6.637	6.696	6.756	6.815	6.875	6.934	6.994	7.053	7.113	7.173	7.234	7.294	7.355	7.415	7.476	7.537	7.598	7.659	7.721	700
800	7.782	7.844	7.905	7.967	8.028	8.090	8.152	8.214	8.277	8.339	8.402	8.464	8.527	8.590	8.653	8.716	8.779	8.842	8.905	8.969	800
900	9.033	9.097	9.161	9.225	9.289	9.353	9.417	9.481	9.545	9.610	9.674	9.739	9.804	9.870	9.935	10.001	10.066	10.132	10.197	10.263	900
1000	10.329	10.395	10.461	10.527	10.593	10.659	10.727	10.794	10.861	10.928	10.996	11.063	11.131	11.198	11.266	11.334	11.402	11.471	11.539	11.607	1000
1100	11.675	11.743	11.812	11.880	11.948	12.017	12.085	12.154	12.223	12.292	12.361	12.430	12.499	12.568	12.637	12.706	12.775	12.844	12.913	12.983	1100
1200	13.051	13.121	13.190	13.260	13.329	13.398	13.468	13.537	13.607	13.676	13.746	13.815	13.885	13.954	14.023	14.093	14.162	14.232	14.301	14.371	1200
1300	14.440	14.510	14.579	14.649	14.718	14.787	14.857	14.926	14.996	15.065	15.134	15.203	15.273	15.342	15.411	15.481	15.550	15.619	15.689	15.758	1300
1400	15.827	15.897	15.966	16.036	16.105	16.175	16.244	16.313	16.382	16.452	16.521	16.591	16.660	16.730	16.798	16.868	16.937	17.006	17.075	17.144	1400
1500	17.213	17.282	17.351	17.419	17.489	17.557	17.626	17.695	17.764	17.832	17.901	17.969	18.037	18.106	18.174	18.243	18.311	18.380	18.448	18.517	1500
1600	18.585	18.654	18.722	18.790	18.859	18.927	18.995	19.063	19.131	19.199	19.267	19.335	19.403	19.472	19.540	19.608	19.676	19.744	19.812	19.880	1600
1700	19.948																				1700

TYPE "Y" (RP1080) IRON-CONSTANTAN THERMOCOUPLE CURVE

Reference Junction at 75°F

Millivolts

°F	-0	-10	-20	-30	-40	-50	-60	-70	-80	-90
-300	-9.13									
-200	-7.27	-7.48	-7.69	-7.89	-8.09	-8.28	-8.46	-8.64	-8.81	-8.98
-100	-4.89	-5.14	-5.39	-5.64	-5.89	-6.13	-6.37	-6.60	-6.83	-7.05
0	-2.18	-2.46	-2.74	-3.02	-3.30	-3.57	-3.84	-4.11	-4.37	-4.63
°F	0	10	20	30	40	50	60	70	80	90
0	-2.18	-1.89	-1.61	-1.32	-1.03	-0.74	-0.44	-0.15	+0.15	+0.44
100	0.74	1.04	1.34	1.64	1.94	2.24	2.55	2.85	3.16	3.46
200	3.77	4.08	4.38	4.69	5.00	5.31	5.62	5.93	6.24	6.55
300	6.86	7.17	7.49	7.80	8.11	8.42	8.74	9.05	9.36	9.67
400	9.98	10.30	10.61	10.92	11.23	11.54	11.85	12.16	12.47	12.78
500	13.09	13.39	13.70	14.01	14.32	14.63	14.94	15.24	15.55	15.86
600	16.17	16.47	16.78	17.08	17.39	17.69	18.00	18.30	18.61	18.92
700	19.22	19.53	19.83	20.14	20.44	20.75	21.05	21.36	21.66	21.97
800	22.27	22.58	22.88	23.19	23.49	23.80	24.11	24.41	24.72	25.03
900	25.33	25.64	25.95	26.26	26.57	26.88	27.19	27.50	27.81	28.13
1000	28.44	28.75	29.07	29.38	29.70	30.02	30.34	30.66	30.98	31.30
1100	31.62	31.94	32.27	32.60	32.92	33.25	33.58	33.91	34.24	34.58
1200	34.91	35.24	35.58	35.92	36.26	36.60	36.94	37.28	37.62	37.97
1300	38.32	38.67	39.02	39.37	39.72	40.08	40.43	40.79	41.14	41.50
1400	41.86	42.22	42.58	42.94	43.30	43.66	44.02	44.39	44.75	45.11
1500	45.48	45.84	46.21	46.57	46.94	47.30	47.67	48.03	48.40	48.76
1600	49.13									

THE BRISTOL COMPANY
WATERBURY, CONNECTICUT 06720, U.S.A.

PARTS LIST
March 1965

P12605

Replaces issue of 8/64

PARTS LIST FOR BRISTOL MODEL 760 & 765 DYNAMASTER RECORDER

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Chart Drive Motors and Change Gear Tables	16, 17, 18, 19

THE BRISTOL COMPANY WATERBURY, CONN. 06720

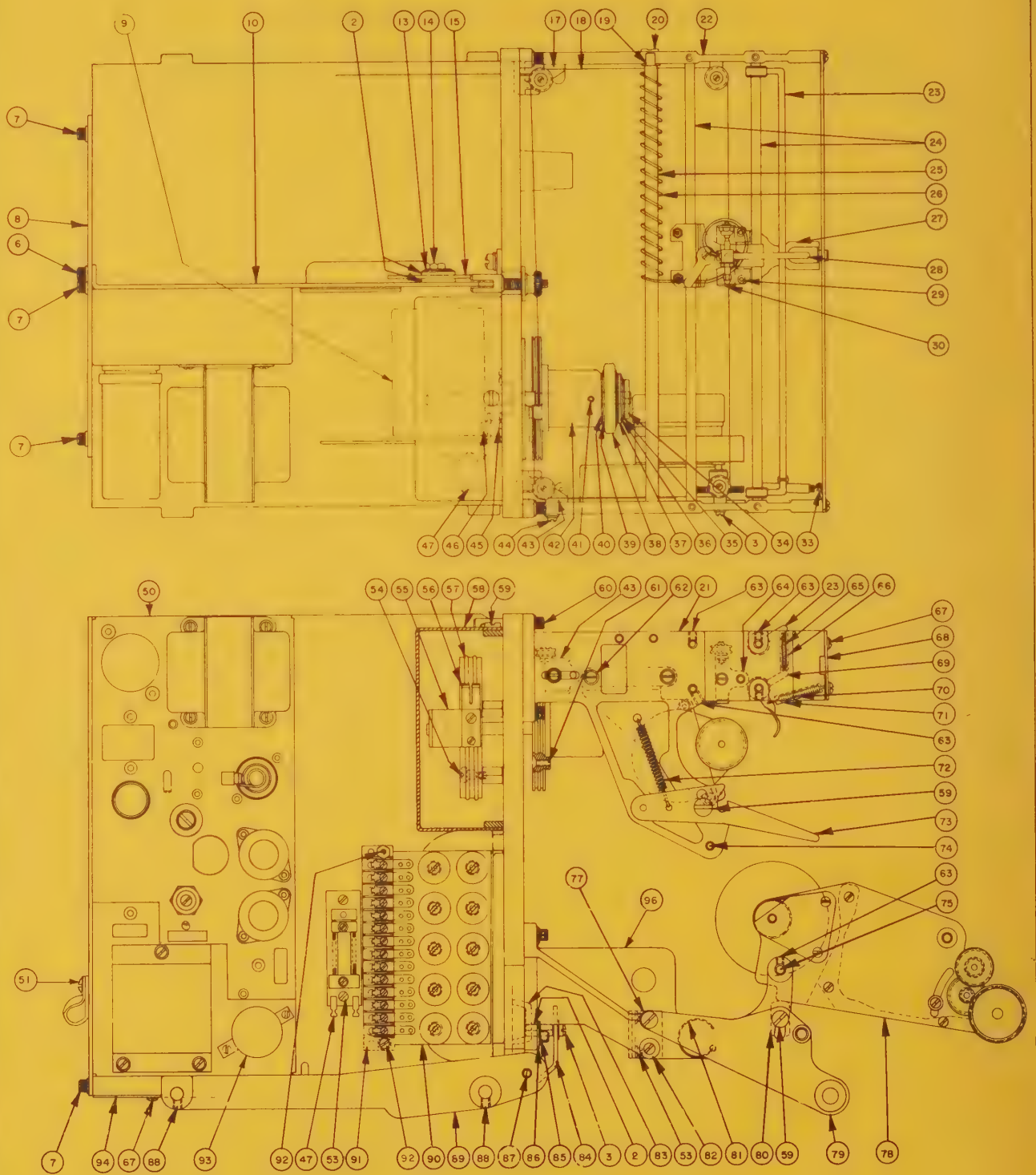


FIGURE 1. TOP AND LEFT SIDE VIEW OF MODEL 760 CHASSIS.

See Pages 4 & 5 for listing of parts

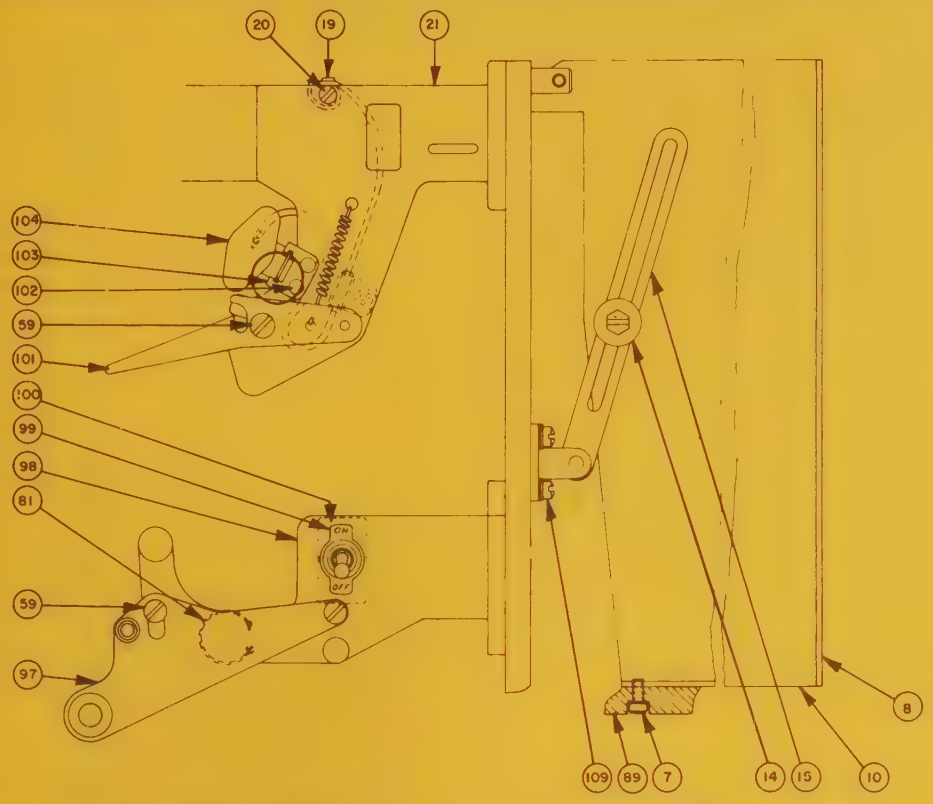


FIGURE 2. RIGHT SIDE VIEW OF CHART DRIVE SUPPORT

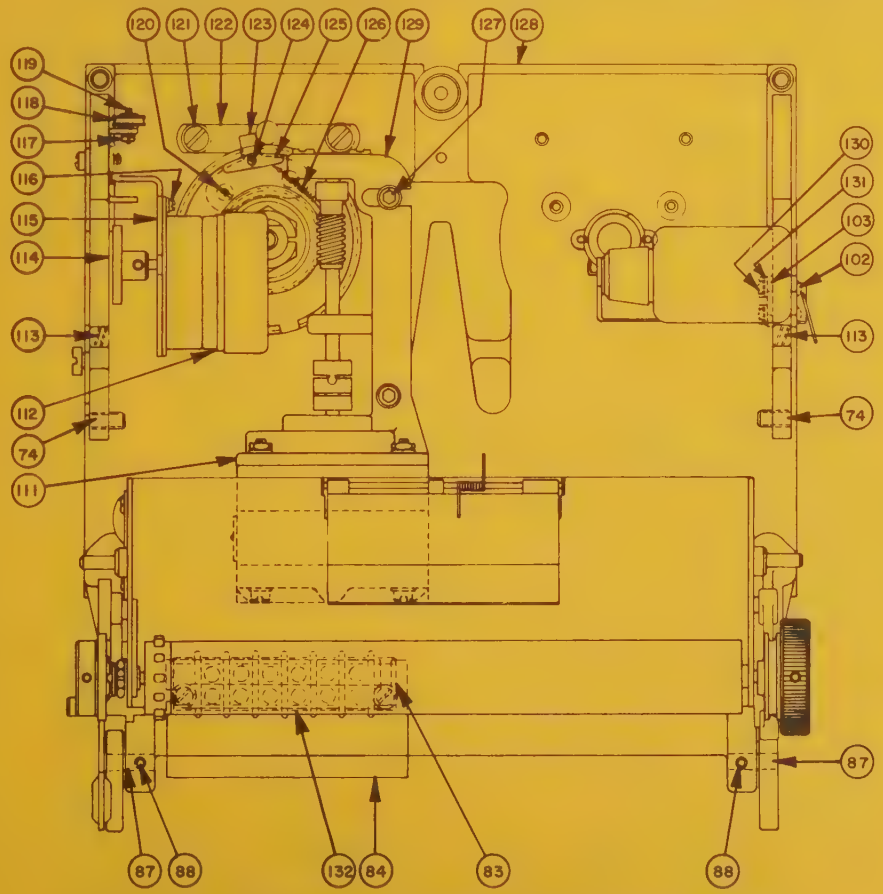


FIGURE 3. FRONT VIEW OF CHASSIS CHART DRIVE FOLDED DOWN.

See Page 4 & 5 for listing of parts.

BE SURE TO STATE MODEL AND SERIAL NUMBERS OF INSTRUMENT WHEN ORDERING PARTS

ITEM NO.	PART NO.	DESCRIPTION
2	A1998	Post
3	39770	#6-40 x 1/4" Fillister-head screw
	21252	Washer
7	A10455	#8-32 x 5/16" Hex socket-head screw
	28543	Lockwasher
8	A10461	Gusset (rear)
9	B2766	Reference voltage source (order with mounting feet A12239, 2 req.)
10	B2657	Partition complete
12	A10453	Washer
13	61812	Spring washer
14	87392	Screw (door stop)
15	A10454	Door stop complete
17	A10431	Pulley bracket (R.H.)
18	A10486	Cord complete
19	A10860	Tab (tube)
20	69109	#6-40 x 1/2" Special-head screw
21	B2683	Pen carriage bracket complete (L.H.)
22	B2682	Pen carriage bracket complete (R.H.)
23	A10451	Pen lifter (upper)
24	A10404	Guide rod
25	A10862	Guide rod (ink supply)
26	A10488	Ink supply tube
27	B2652	Indicator #1 position
28	A10460	Pen #1 position
29	37603	#2-64 x 3/16" Fillister-head screw
	68791	Lockwasher
	19890	#2 Hex nut
30	A10434	Pen guide assembly
33	64536	Lug
34	A3874	1/2 - 27 Nut with slot
35	79235	Washer
36	75855	Spring washer
37	79237	"D" washer
38	A4566	Potentiometer worm wheel for 1-sec. pen speeds
	A10882	Potentiometer worm wheel for 5-sec. pen speeds
39	A1883	Clutch washer
40	A6791	Washer
41	A4414	#8-32 x 3/16" Flat-point setscrew
	A10385	Shaft complete
42	A10387	Clutch hub #1 pen
43	A10430	Pulley bracket (L.H.)
44	58073	#6-40 x 7/16" Fillister-head screw
	43040	Shakeproof washer
	21252	Washer
45	A2734	#6-40 x 1/4" Special-head screw
46	40067	#8-32 x 3/8" Fillister-head screw
	35638	Shakeproof washer
47		Trimmer (specify model, range and serial numbers of instrument)
	B1505	2 - ohm)
	95412	8 - ohm)
	95413	16 - ohm) as required
	96140	24 - ohm)
	96168	40 - ohm)
	A10373	Mounting bracket complete
50		Amplifier (specify model and serial numbers of instrument)
51	75373	6-40 x 1/4" Washer-head screw
	95380	Cable clip
54	A9835	#6-40 Shoulder screw
	A10499	Slidewire post
55	A10653	Brush arm complete (does not include contact, item 56)
56	B1464	Slidewire contact arm
57		Slidewire (specify model, range and serial number of instrument)
58	A10456	Slidewire cover
59	A10416	#6-40 Shoulder screw
60	A10380	#8-32 x 5/8" Hex socket-head cap screw
	35638	Shakeproof washer
61	21104	#4-48 x 5/16" Fillister-head screw
	A10389	Sheave
62	31427	#6-40 x 5/16" Fillister-head screw
	79008	Lockwasher
63	82400	#6-40 x 1/8" Cup-point setscrew
64	A10429	Pulley bracket (front)
65	61241	Spring
66	A10452	Tube 3/4" (short)
67	68345	#6-40 x 3/16" Special-head screw
68		Scale (specify model, range and serial numbers of instrument)
69	A10445	Pen lifter (lower)

BE SURE TO STATE MODEL AND SERIAL NUMBERS OF INSTRUMENT WHEN ORDERING PARTS

ITEM NO.	PART NO.	DESCRIPTION
70	12366	Spring
71	A10483	Tube 1" (long)
72	A10425	Spring
73	A10415	Lever complete (L.H.)
74	A10417	#10-32 x 1/2" Oval-point setscrew
75	A10443	Pin (chart drive)
77	A10422	Bracket
	A10424	Plate
78	C2338	Chart drive (see pages 6 & 7)
79	A10421	Chassis latch (L.H.)
80	A10423	Stop
81	A10426	Latch spring
82	58073	#6-40 x 7/16" Fillister-head screw
	43040	Shakeproof washer
83	A4075	Terminal block (6 point)
84	A10877	Terminal cover
	49767	Post
85	21252	Washer
86	A10888	Marking strip
87	A10444	Shaft pivot
88	85853	#6-40 x 1/4" Cup-point setscrew
89	C2340	Rear frame
90	A10377	Card only (interchangeable)
		Spool card complete (specify model, range and serial numbers of instrument)
91	A10378	Terminal block (14 point)
92	74929	4-48 x 3/8" Fillister-head screw
93	C1415-2	Syncroverter switch
Not Shown	A5990	Shorting plug used on A-C bridges (plugs into syncroverter socket)
94	A10494	Cover (rear frame)
96	B2685	Chart drive support (L.H.)
97	A10418	Chassis latch complete (R.H.)
98	B2684	Chart drive support (R.H.)
99	63786	Switch plate (on-off)
100	A13505	Switch (on-off)
101	A10412	Lever complete (R.H.)
102		#6-32 x 1/2" Hex button-head screw
103	A10849	Slide bracket
104	A10856	Reservoir assembly #1 pen
	A12978	Red ink (1-1/4 oz. bottle)
	A12979	Blue ink (1-1/4 oz. bottle)
107	A10885	Marking strip
108	A4553	Terminal block (3 point)
109	A9811	#8-32 x 1/2" Fillister-head screw
	35638	Shakeproof washer
	2420	Washer
111	B2658	Balancing motor
	2420	Washer
	26966	Hex nut
	A10406	Coupling
	A10407	Shaft complete
	82403	Set screw
	A4567	Worm gear for 1 sec. pen speed
	A1881	Worm gear for 5 sec. pen speed
	A2734	Special head screw
112		Chart drive motor (see Figure 10, page 11)
113	A10384	#6-32 x 5/8" Oval-point setscrew
114		Change gear (see Figure 10, page 11)
115	B2646	Motor bracket
116	40747	#6-40 x 1/8" Fillister-head screw
	79008	Lockwasher
117	19890	#2 Hex nut
	68791	Lockwasher
118	A4527	Pulley
119	A3263	#2-64 x 3/8" Fillister-head screw
120	12016	#4-48 x 3/16" Flat-head screw
121	A2734	#6-40 x 1/4" Special-head screw
	43040	Shakeproof washer
	21252	Washer
122	A10381	Stop (strap complete)
123	A10391	Stop (L.H.) #1 pen
124	10626	#4-48 x 1/8" Fillister-head screw
125	A10392	Cord clamp
126	A10484	Spring cord
127	A10411	#10-32 x 1 3/4" Hex-socket cap screw
	34078	#10 Lockwasher
128	D1434	Back
129	A10405	Balancing-motor bracket
130	41463	#6-32 x 5/16" Hex nut
131	43040	Shakeproof washer
132	A10888	Marking strip
Not Shown	A12772	Decal (small)
	A12771	Decal (large)
		PARTS USED FOR 2-PEN ASSEMBLY
18	A10487	Cord complete
26	A10863	Ink supply tube
	A10859	Ink supply tube (short)
27	A10866	Indicator #2 position
28	A10490	Pen #2 position
	A10492	Indicator bracket
30	A10897	Pen guide assembly
42	A10481	Clutch hub
104	A10858	Reservoir assembly
122	A10496	Stop (strap complete)
123	A10480	Stop (R.H.)

Refer to pages 2 & 3 for illustrations

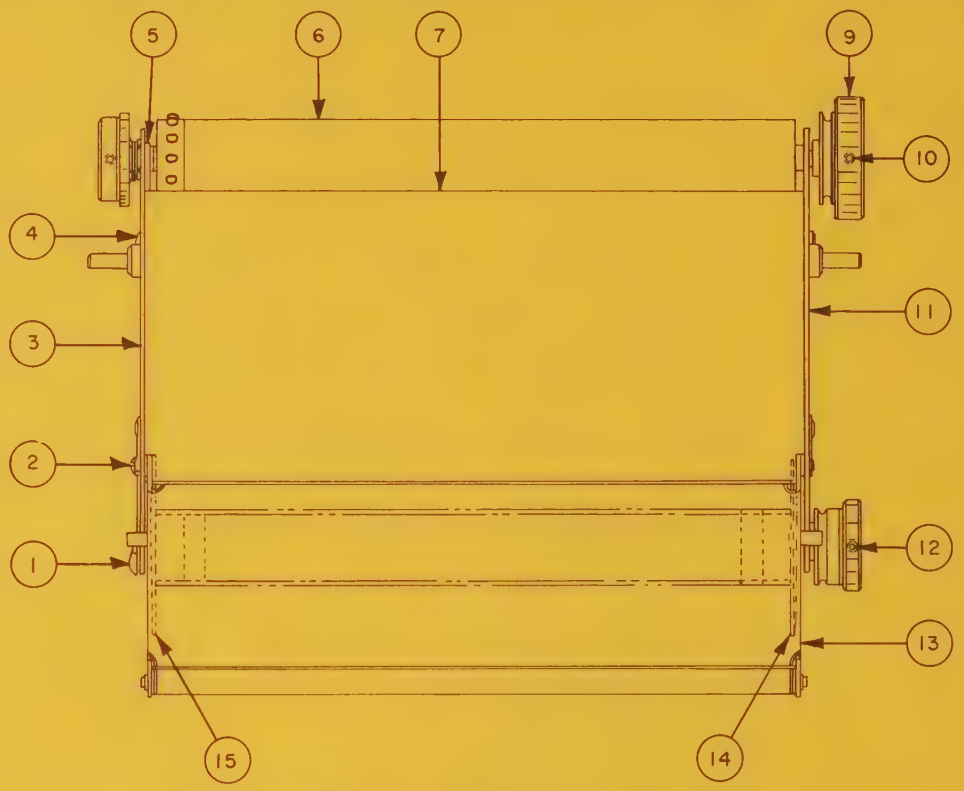


FIGURE 4. FRONT VIEW OF MODEL 760 CHART DRIVE

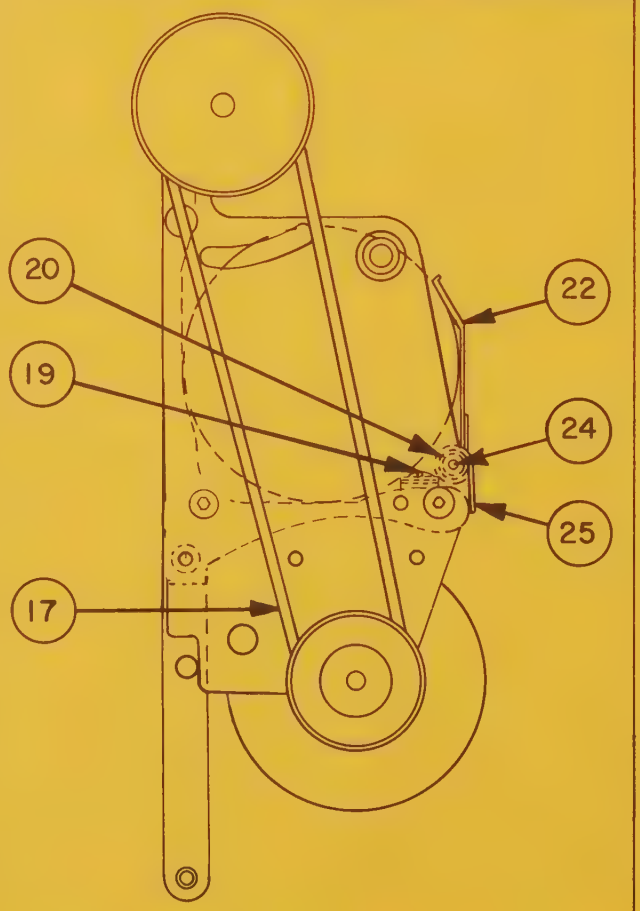


FIGURE 5. RIGHT SIDE VIEW OF MODEL 760 CHART DRIVE

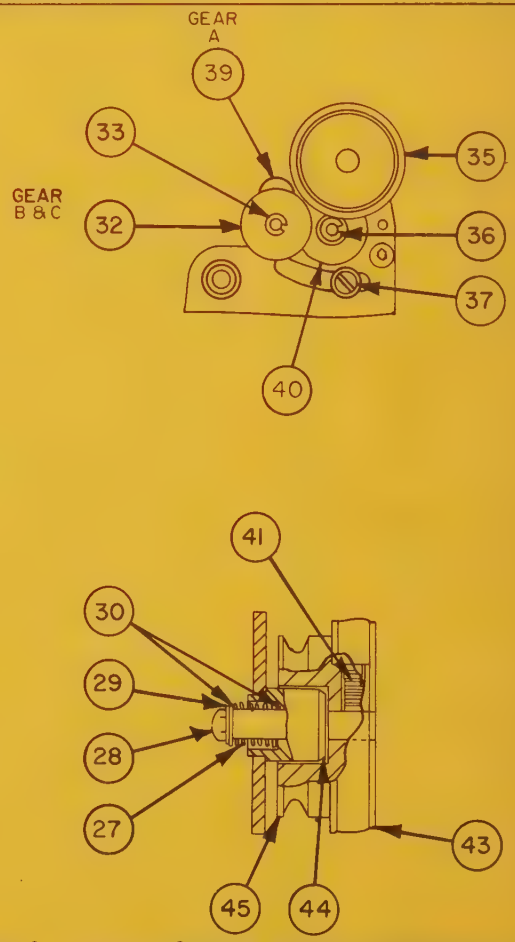


FIGURE 6. MODEL 760 CHART DRIVE CHANGE GEARS & CLUTCH

BE SURE TO STATE MODEL AND SERIAL NUMBERS OF INSTRUMENT WHEN ORDERING PARTS

ITEM NO.	PART NO.	DESCRIPTION
1	A10352	Rewind roll positioning plate
2	68345	#6-40 x 3/16" Special-head screw
3	A10327	Side plate complete (L.H.)
4	A10329	Button-head socket shoulder screw
5	A10335	Bracket complete
6	A10330	Drive roll complete
7	B2636	Chart drive body
9	A10348	Pulley drive roll
10	82403	#6-40 x 1/8" Flat-point setscrew
11	A10322	Side plate complete (R.H.)
12	82403	#6-40 x 1/8" Flat-point setscrew
13	B2638	Bracket complete
14	A10353	Rewind complete (Right end)
15	A10357	Rewind complete (Left end)
17	A10367	Spring drive
19	68345	#6-40 x 3/16" Special-head screw
20	94410	"E" ring
22	C2343	Friction plate
24	A10351	Shaft
25	A7338	Spring
27	A7343	Spring
28	A10360	Pin
29	92268	"E" ring
30	A7350	Washer
32		Gear complete (see Figure 10, page 11)
33	A7325	"E" ring
35	A10345	Clutch assembly
36	A7325	"E" ring
37	68345	#6-40 x 3/16" Special-head screw
	21252	Washer
39		Motor pinion "Gear A" (see Figure 10, 11A or 11B)
40	A10338	Idler gear complete
41	82403	#6-40 x 1/8" Flat-point setscrew
43	A10369	Knob
44	A7344	Washer
45	A10361	Rewind pulley

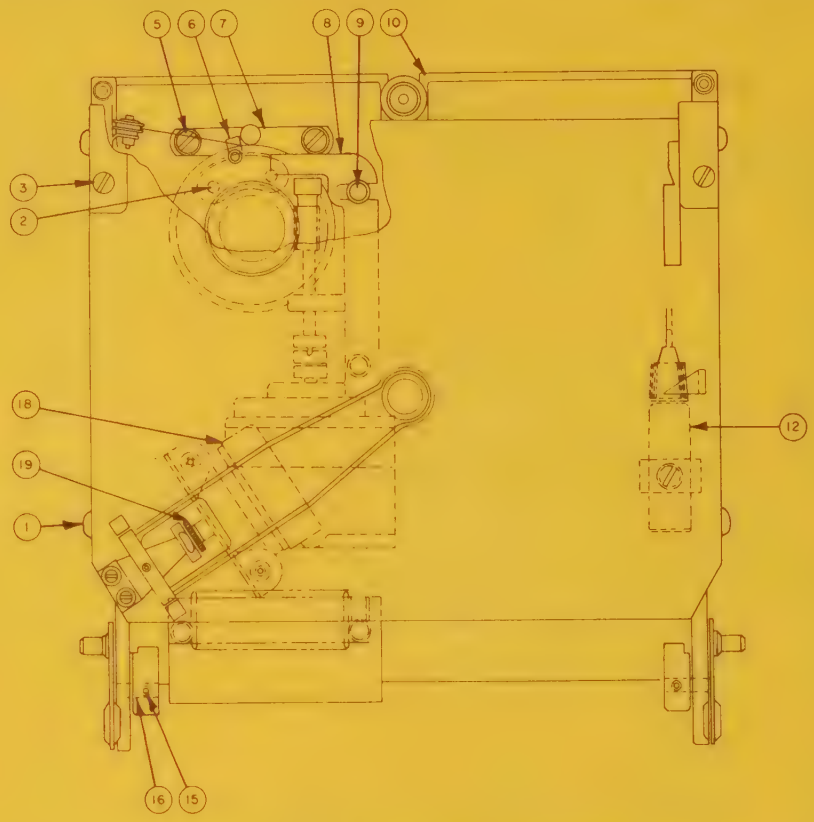


FIGURE 7. FRONT VIEW OF MODEL 765 ROUND-CHART DYNAMASTER

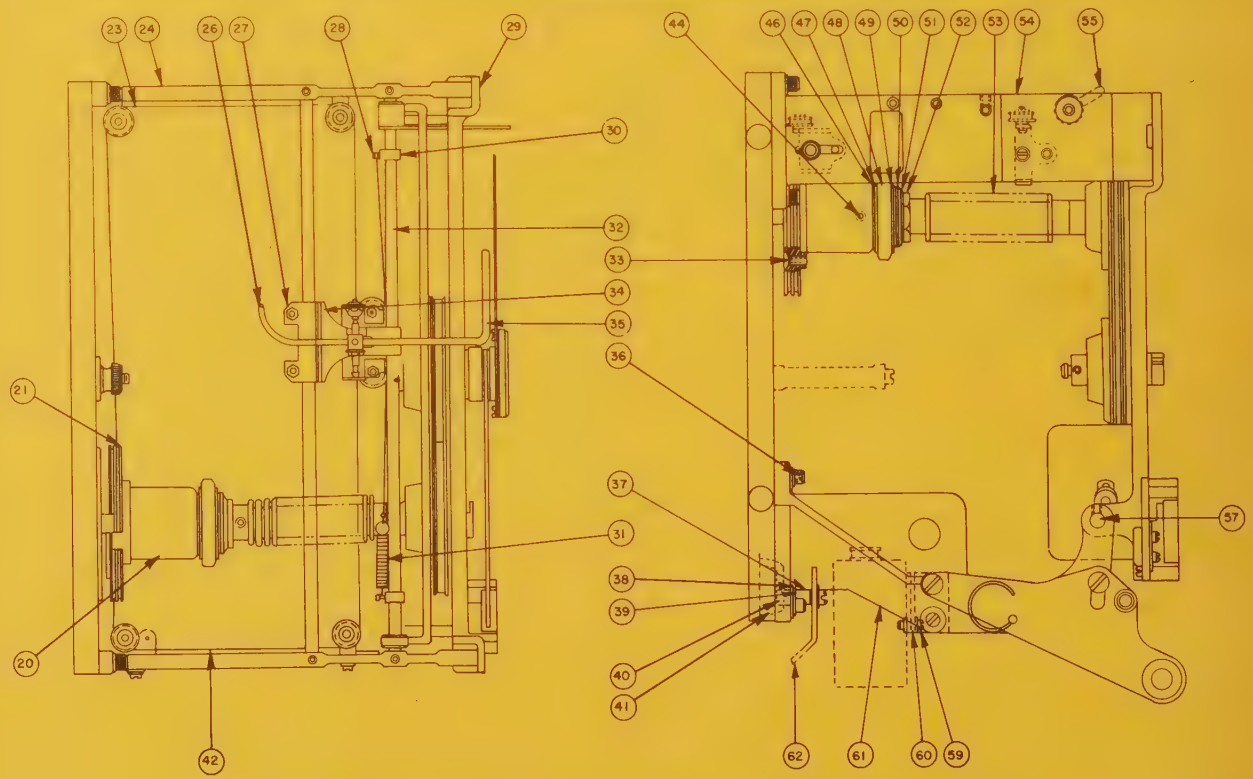


FIGURE 8. TOP & LEFT SIDE VIEW OF MODEL 765 ROUND-CHART DYNAMASTER

BE SURE TO STATE MODEL AND SERIAL NUMBERS WHEN ORDERING PARTS

ITEM NO.	PART NO.	DESCRIPTION
1	A10880	#10-32 x 1/2" Button-head screw
2	12016	#4-48 x 3/16" Flat-head screw
3	7953	#6-40 x 3/8" Flat-head screw
5	A2734	#6-40 x 1/4" Special-head screw
	21252	Washer
	43040	Shakeproof washer
6	A10391	Stop
7	A10381	Stop (strap complete)
8		Potentiometer motor speed parts (specify model, range and serial number of instrument)
9	97271	#10-32 x 1 5/8" Hex socket-cap screw
10	D1434	Back
12	A6356	Ink reservoir assembly
15	85853	#6-40 x 1/4" Cup-point setscrew
16	A10444	Shaft pivot
18		Chart drive motors (round chart)
	A10825	120V. 60cy., 1.5 rph motor for 8-hr. chart rotation
	A11729	120V. 50cy., 1.5 rph motor for 8-hr. chart rotation
	A11361	120V. 60cy., 1 rph motor for 12-hr. chart rotation
	A11725	120V. 50cy., 1 rph motor for 12-hr. chart rotation
	A11362	120V. 60cy., 1/2 rph motor for 24-hr. chart rotation
	A11726	120V. 50cy., 1/2 rph motor for 24-hr. chart rotation
	A11363	120V. 60cy., 1/6 rph motor for 72-hr. chart rotation
	A11727	120V. 50cy., 1/6 rph motor for 72-hr. chart rotation
	A11364	120V. 60cy., 1/15 rph motor for 7-day chart rotation
	A11728	120V 50cy., 1/15 rph motor for 7-day chart rotation
	A3544	Motor pinion
19		Friction drive wheel
	A10814	For 8-hour, 12-hour, 24-hour and 72-hour chart rotation
	A10815	For 7-day chart rotation
20	A10387	Clutch hub
21	B2661	Sheave complete
23	A10841	Cord complete (R.H.)
24	B2686	Pen carriage bracket (L.H.)
26	A10864	Ink supply tube
27	A10847	Pen guide assembly
28	33522	#2-64 x 1/8" Fillister-head screw
29	C2346	Chart plate
30	33848	Collar
31	A4157	Spring (cord)
32	A10404	Guide rod
33	21104	#4-48 x 5/16" Flat-head screw
34	A10847	Pen guide assembly
35	A10833	Pen
36	97271	#10-32 x 1 5/8" Hex socket-cap screw
	10075	Washer
	35638	Shakeproof washer
37	49767	Post
38	A10888	Marking strip
39	21252	Washer
40	A1998	Post
41	A4075	Terminal block (6-point)
42	A10842	Cord complete (L.H.)
44	A4414	#8-32 x 3/16" Flat-point setscrew
46	A6791	Washer
47	A1883	Clutch washer
48		Potentiometer worm wheel (specify model, range and serial number of instrument)
49	79237	"D" washer
50	75855	Spring washer
51	79235	Washer
52	A3874	1/2 - 27 Nut with slot
53	A10840	Bellows
54	B2687	Pen carriage bracket (R.H.)
55	A10837	Pen lifter
57	A10443	Pin (chart plate)
59	18339	#6-40 x 3/16" Fillister-head screw
60	A10424	Plate
61	B2684	Chart drive support (R.H.)
	B2685	Chart drive support (L.H.)
62	A10877	Cover-terminal

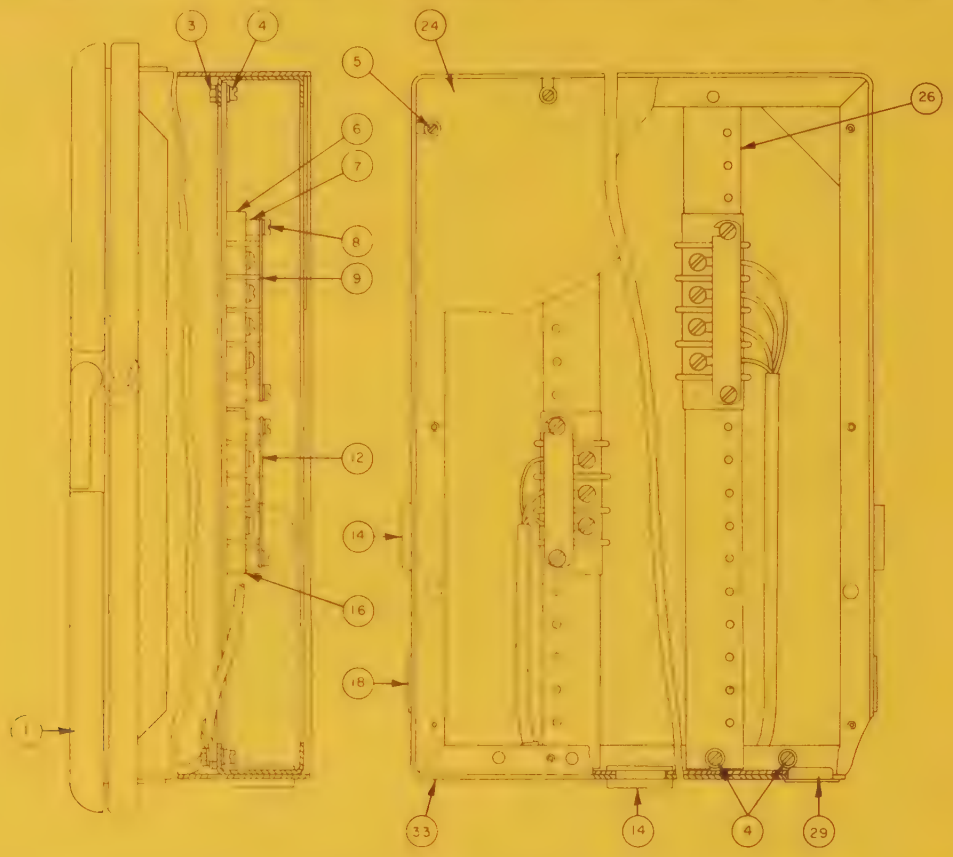


FIGURE 9. SIDE AND REAR VIEW OF MODEL 760 & 765 CASE.

BE SURE TO STATE MODEL AND SERIAL NUMBERS OF INSTRUMENT WHEN ORDERING PARTS

ITEM NO.	PART NO.	DESCRIPTION
1	C2336	Cover complete (strip type, model 760)
	C2349	Cover complete (dial type, model 765)
	B2631	Handle
	A10307	Spring
	A10308	Hook
	A10309	#6-40 Special dog-point setscrew
	A2868	Gasket (45")
	A10310	Gasket (Black spring cork 36")
	A10311	Glass
	A10313	Clip (long)
	82656	#6-32 x 3/16" Self-tapping screw
	A10314	Chart shield (R.H.)
	A10315	Chart shield (L.H.)
	77982	#6-32 x 3/16" Fillister-head screw
	A10370	Bottom shield
3	62618	#10-32 Nut
	35638	Shakeproof washer
4	66539	#10-32 x 3/8" Fillister-head screw
	10075	Washer
5	75373	#6-40 x 1/4" Washer-head screw
6	87236	Terminal block (4-point)
7	72166	Spacer
8	87936	#10-32 x 1" Self-tapping screw
	10075	Washer
9	A10886	Marking strip
12	A10887	Marking strip
14	72691	Rubber plug
16	87235	Terminal block (3-point)
18	A7276	Plastic plug

-continued on page 11-

-continued from page 10-

ITEM NO.	PART NO.	DESCRIPTION
24	B2634	Cover (rear frame)
26	B2688	Mounting strap
29	91250	Metal plug
33	D1431	Case body complete
	C2335	Case body and track complete
	A10303	Roller
	A10304	6-40 shoulder screw
	13775	6-40 Nut
	B2632	Intermediate channel
	A10316	Center track, chassis mounting
	43040	Lockwasher

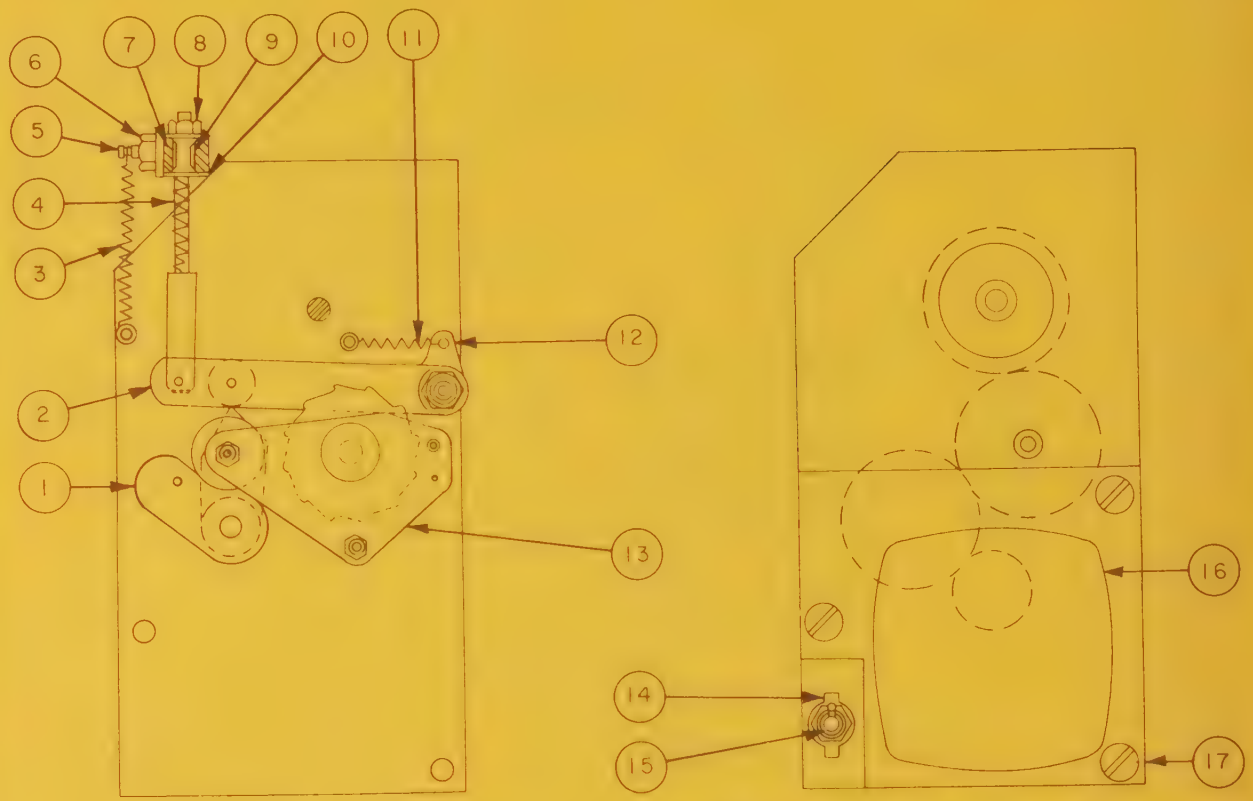


FIGURE 10. MULTIPLE PRINTING MECHANSIM COMPLETE SERIES 760 DYNAMASTER.

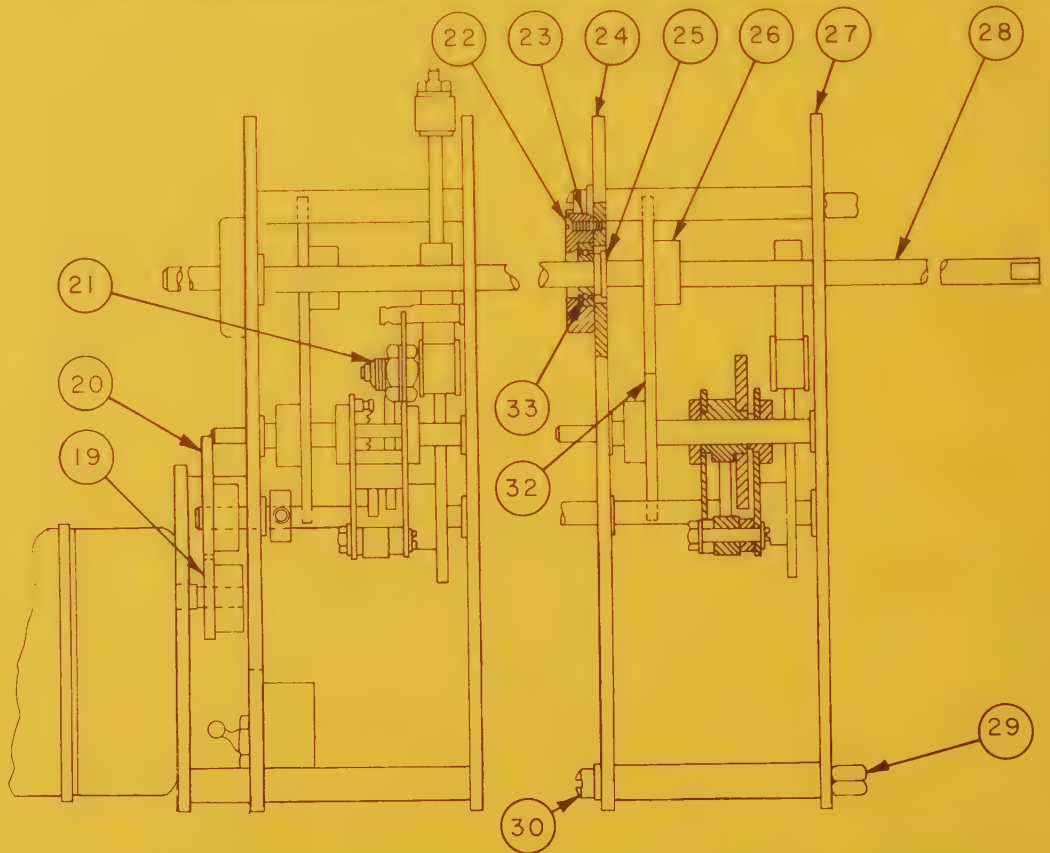


FIGURE 11. MULTIPLE PRINTING MECHANISM COMPLETE SERIES 760 DYNAMASTER

BE SURE TO STATE MODEL AND SERIAL NUMBERS OF INSTRUMENT WHEN ORDERING PARTS

ITEM	PART NO.	DESCRIPTION
	C2906	Multiple mechanism complete for 7" Dynamaster
1	B3308	Cam shaft and lever complete
2	B3306	Printing lever complete
3	A12102	Printing lever spring
4	88080	Printing pressure spring
5	88081	Depressor yoke
6	89653	Depressor yoke nut
7	88083	Yoke washer
8	82647	6-40 Self-locking nut
9	95913	Sleeve
10	88082	Spring collar
11	88032	Latch lever spring
12	95556	Latch lever complete
13	98027	Ratchet shaft and pawl lever complete
14	63786	Switch plate
15	A5288	Power switch
16	96738	Motor, 120 volt, 50-60 cycle for 60-second print interval
	88060	Motor, 120 volt, 50-60 cycle for 8-, 15-, 30-second print interval
	92128	Motor, 120 volt, 50-60 cycle for 1.9-, 3.9-second print interval
	90059	Capacitor for motor (not shown)
17	A12106	Motor mounting plate
	53732	Screw
	26966	Nut
	28543	Washer
19		Motor pinion
	92129	(46T - 48P) for 8-second print interval
	94261	(22T - 48P) for 3.9- or 60-second print interval
	88061	(19T - 48P) for 30-second print interval
	89150	(36T - 48P) for 15-second print interval
	94460	(37T - 48P) for 1.9-second print interval
	82413	10-32 x 3/16" Bristo flat-point setscrew for item 19.
20		Gear, including setscrew
	92131	(62T - 48P) for 8-second print interval
	94263	(86T - 48P) for 3.9-, or 60-second print interval
	88014	(89T - 48P) for 15-or 30-second print interval
	94462	(71T - 48P) for 1.9-second print interval
	82413	10-32 x 3/16" Bristo flat-point setscrew for item 20
21	79854	Waldes Tru-arc retaining ring
22	89037	#4-48 x 3/8" flat-head screw
23	88086	Bearing housing
24	B3307	Back plate complete
25	91015	Retaining ring
	61381	Thrust washer
26		Switch shaft gear
	A12104	(60T - 48P) 2, 3 or 6-point instrument
	A12105	(60T - 48P) 4, or 8-point instrument
	86076	(75T - 48P) 12-point instrument
27	B3305	Front plate complete
28	A12103	Switch shaft
29	A12110	Post
30	66539	10-32 x 1/2" Fillister-head screw
	35638	#10 Shakeproof washer
32		Ratchet shaft gear
	88037	(100T - 48P) for 2, 3 or 6-point instrument
	88072	(90T - 48P) for 4 or 8-point instrument
	86076	(75T - 48P) for 12-point instrument
33	88085	Switch shaft bearing
NOT SHOWN		
	98011	Switch plate and Contact arm for 2, 3, 4, 6, 8, 12, 24 point multiple.
	98013	Contact arm only for above.

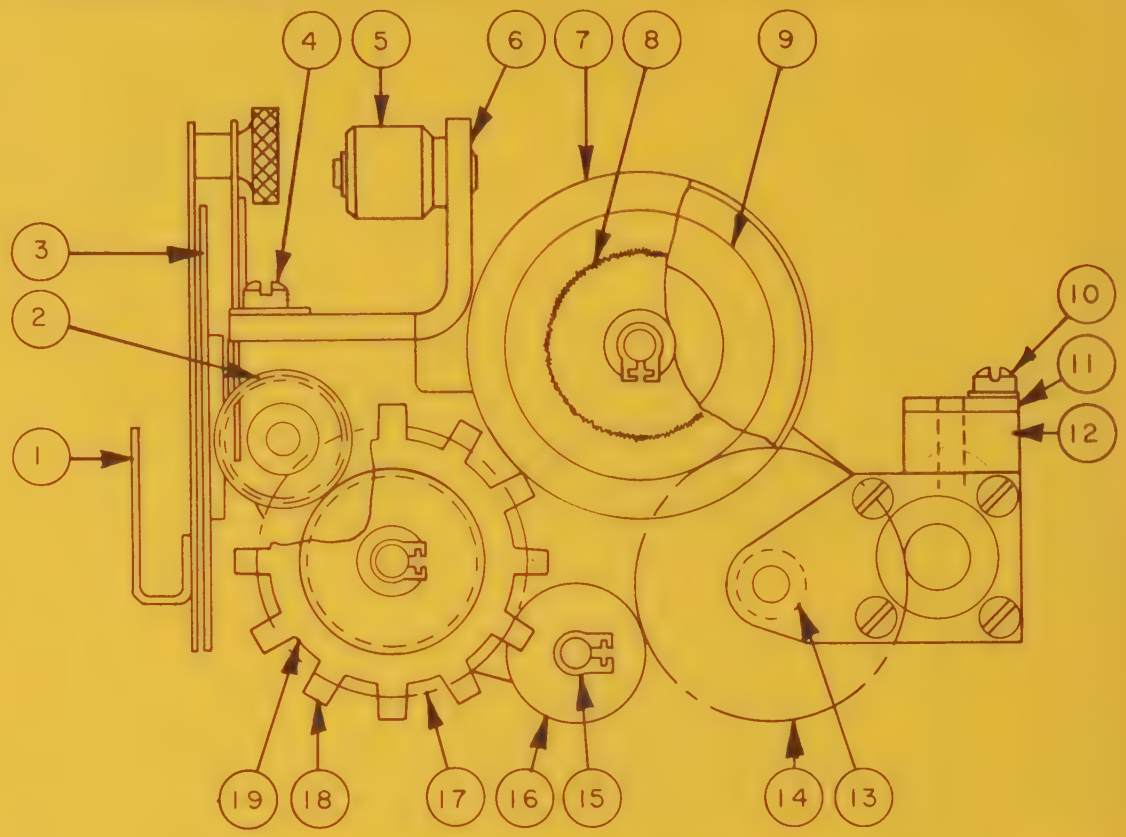


FIGURE 12. MULTIPLE PRINTING ASSEMBLY COMPLETE

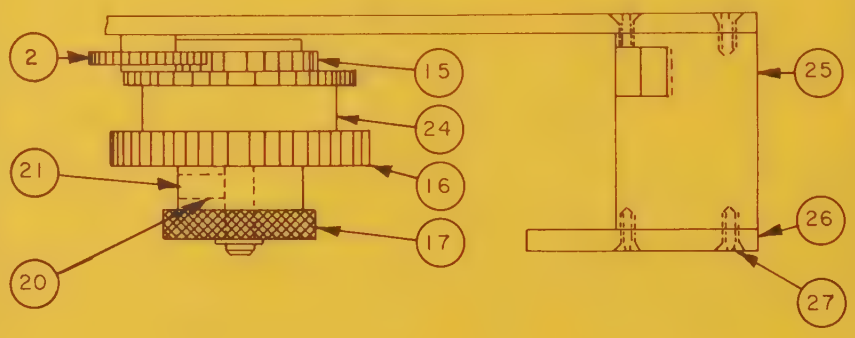


FIGURE 13. INK ROLL AND GEAR ASSEMBLY COMPLETE

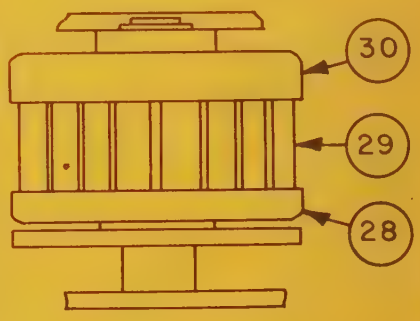


FIGURE 14. FELT HOLDER COMPLETE

BE SURE TO STATE MODEL AND SERIAL NUMBERS OF INSTRUMENT WHEN ORDERING PARTS

ITEM	PART NO.	DESCRIPTION
1	B2831	Shield and pointer assembly
2	A9419	Gear
3		DESIGNATION DISK

A12146 - 2 point	A12130 - 6 point
A12147 - 3 point	A12119 - 8 point
A12148 - 4 point	A11953 -12 point

4	65071	#3-56 x 1/8" Fillister-head screw
5	86070	Roller complete
6	B3300	Left side plate assembly
7	A10561	Ink roll assembly complete for 1-color printing (purple)
	A9400	Felt
	A12467	Washer
	89898	Nut
8	A9411	Thumb nut
9	88197	Gear assembly
10	36111	#4-48 x 7/16" Fillister-head screw
	45692	#4 Shakeproof washer
11	A11981	Cord clamp
12	A11979	Spacer complete
13	60125	Washer
14	86072	Gear assembly
	A12468	Washer
15	80607	Retaining ring
16	A12715	Gear
17	A9437	Gear assembly
18		TYPE WHEEL (DOTS AND NUMBERS)

A12136 - 2 point	A12116 - 6 point
A12137 - 3 point	A12113 - 8 point
A12138 - 4 point	A12111 -12 point

19	A9412	Thumb nut
20	A7349	Nylon pad
21	82404	#6-40 Flat-head setscrew
24	A9458	Hub complete
25	A11977	Frame block complete
26	A11978	Plate (right hand)
27	A4770	#2-64 x 3/16" Fillister-head screw
28	B3506	Felt holder (6-segment)
	B3507	Felt holder (8-segment)
	B3508	Felt holder (12-segment)
29		INKING FELTS (CONTAINER OF 6)

	Black	Red	Purple	Green	Blue	Brown
6-segment	A12518	A12519	A12520	A12521	A12522	A12523
8-segment	A12514	A12515	A12516	A12517		
12-segment	91006	91007	91008	91009	A12512	A12513

30 FELT HOLDER CAPS

A12786 - 2 point	A12789 - 6 point
A12787 - 3 point	A12790 - 8 point
A12788 - 4 point	A12791 -12 point

CHART DRIVE MOTORS						CHANGE GEARS			
2 RPM 120 V. 60 CYC. A10497	2 RPM 120 V. 50 CYC. A11730	8 RPM 120 V. 60 CYC. A13629	8 RPM 120 V. 50 CYC. A13630	8 RPH 120 V. 60 CYC. A10394	8 RPH 120 V. 50 CYC. A11732	GEAR	TEETH	PITCH	PART NUMBER
CHART SPEED INCHES/MIN.				CHART SPEED INCHES/HR.					
3/16	3/16	3/4	3/4	3/4	3/4	A B*	12 48	64 64	A10402 A10342
1/4	1/4	1	1	1	1	A B*	16 48	64 64	A10399 A10342
3/8	3/8	1 1/2	1 1/2	1 1/2	1 1/2	A C*	12 24	64 64	A10402 A10342
1/2	1/2	2	2	2	2	A C*	16 24	64 64	A10399 A10342
3/4	3/4	3	3	3	3	A B*	48 48	64 64	A10398 A10342
1	1	4	4	4	4	A B*	64 48	64 64	A10395 A10342
1 1/2	1 1/2	6	6	6	6	A C*	48 24	64 64	A10398 A10342
2	2	8	8	8	8	A C*	64 24	64 64	A10395 A10342

FIGURE 15. TABLE OF MOTORS AND CHANGE GEARS FOR SINGLE-SPEED CHART DRIVES ON STRIP-CHART RECORDERS

*Gears B & C are combined to form a double gear.

CHART DRIVE MOTORS (RPM)												CHANGE GEARS			
8 RPM 120 V. 60 CYC. B3340 10-1 Ratio		8 RPM 120 V. 60 CYC. B3341 30-1 Ratio		8 RPM 120 V. 60 CYC. B3342 60-1 Ratio		8 RPM 120 V. 50 CYC. B3349 10-1 Ratio		8 RPM 120 V. 50 CYC. B3350 30-1 Ratio		8 RPM 120 V. 50 CYC. B3351 60-1 Ratio		GEAR POSITION	TEETH	PITCH	PART NUMBER
CHART SPEED, INCHES PER MINUTE															
FAST	SLOW	FAST	SLOW	FAST	SLOW	FAST	SLOW	FAST	SLOW	FAST	SLOW				
3/4	.075	3/4	.025	3/4	.0125	3/4	.075	3/4	.025	3/4	.0125	A B	12 48	64 64	A10402 A10403
1	.1	1	.033	1	.0166	1	.1	1	.033	1	.0166	A B	16 48	64 64	A10399 A10342
1 1/2	.15	1 1/2	.05	1 1/2	.025	1 1/2	.15	1 1/2	.05	1 1/2	.025	A C	12 24	64 64	A10402 A10342
2	.2	2	.066	2	.033	2	.2	2	.066	2	.033	A C	16 24	64 64	A10399 A10342
3	.3	3	.1	3	.05	3	.3	3	.1	3	.05	A B	48 48	64 64	A10398 A10342

FIGURE 16A. TABLE OF MOTORS AND CHANGE GEARS FOR 2-SPEED CHART DRIVES ON STRIP CHART RECORDERS (ATT. TD84)

CHART DRIVE MOTORS (RPM)												CHANGE GEARS			
16 RPM 120 V. 60 CYC. B3531 10-1 Ratio		16 RPM 120 V. 60 CYC. B3532 30-1 Ratio		16 RPM 120 V. 60 CYC. B3533 60-1 Ratio		16 RPM 120 V. 50 CYC. B3534 10-1 Ratio		16 RPM 120 V. 50 CYC. B3535 30-1 Ratio		16 RPM 120 V. 50 CYC. B3536 60-1 Ratio		GEAR POSITION	TEETH	PITCH	PART NUMBER
CHART SPEED, INCHES PER MINUTE															
FAST	SLOW	FAST	SLOW	FAST	SLOW	FAST	SLOW	FAST	SLOW	FAST	SLOW				
4	.4	4	.133	4	.066	4	.4	4	.133	4	.066	A C	16 24	64 64	A10399 A10342
6	.6	6	.2	6	.1	6	.6	6	.2	6	.1	A B	48 48	64 64	A10398 A10342
8	.8	8	.266	8	.133	8	.8	8	.266	8	.133	A B	64 48	64 64	A10395 A10342
12	1.2	12	.400	12	.2	12	1.2	12	.400	12	.2	A C	48 24	64 64	A10398 A10342
16	1.6	16	.533	16	.266	16	1.6	16	.533	16	.266	A C	64 25	64 64	A10395 A10342

FIGURE 16B. TABLE OF MOTORS AND CHANGE GEARS FOR 2-SPEED CHART DRIVES ON STRIP CHART RECORDERS (ATT. TD84)

CHART DRIVE MOTORS (RPM)												CHANGE GEARS			
30 RPM 120 V. 60 CYC. B3580 10-1 Ratio		30 RPM 120 V. 60 CYC. B3581 30-1 Ratio		30 RPM 120 V. 60 CYC. B3582 60-1 Ratio		30 RPM 120 V. 50 CYC. B3583 10-1 Ratio		30 RPM 120 V. 50 CYC. B3584 30-1 Ratio		30 RPM 120 V. 50 CYC. B3585 60-1 Ratio		GEAR POSITION	TEETH	PITCH	PART NUMBER
CHART SPEED, INCHES PER MINUTE															
FAST	SLOW	FAST	SLOW	FAST	SLOW	FAST	SLOW	FAST	SLOW	FAST	SLOW				
2 13/16	9/32	2 13/16	3/32	2 13/16	3/64	2 13/16	9/32	2 13/16	3/32	2 13/16	3/64	A B	12 48	64 64	A10402 A10342
3 3/4	3/8	3 3/4	1/8	3 3/4	1/16	3 3/4	3/8	3 3/4	1/8	3 3/4	1/16	A B	16 48	64 64	A10399 A10342
5 5/8	9/16	5 5/8	3/16	5 5/8	3/32	5 5/8	9/16	5 5/8	3/16	5 5/8	3/32	A C	12 24	64 64	A10402 A10342
7 1/2	3/4	7 1/2	1/4	7 1/2	1/8	7 1/2	3/4	7 1/2	1/4	7 1/2	1/8	A C	16 24	64 64	A10399 A10342
11 1/4	1 1/8	11 1/4	3/8	11 1/2	3/16	11 1/4	1 1/8	11 1/4	3/8	11 1/2	3/16	A B	48 48	64 64	A10398 A10342
15	1 1/2	15	1/2	15	1/4	15	1 1/2	15	1/2	15	1/4	A B	64 48	64 64	A10395 A10342
22 1/2	2 1/2	22 1/2	3/4	22 1/2	3/8	22 1/2	2 1/2	22 1/2	3/4	22 1/2	3/8	A C	48 24	64 64	A10398 A10342
30	3	30	1	30	1/2	30	3	30	1	30	1/2	A C	64 24	64 64	A10395 A10342

FIGURE 16C. TABLE OF MOTORS AND CHANGE GEARS FOR 2-SPEED CHART DRIVES ON STRIP CHART RECORDERS (ATT. TD84)

CHART DRIVE MOTORS (RPH)												CHANGE GEARS			
8 RPH 120 V. 60 CYC. B3343 10-1 Ratio		8 RPH 120 V. 60 CYC. B3344 30-1 Ratio		8 RPH 120 V. 60 CYC. B3345 60-1 Ratio		8 RPH 120 V. 50 CYC. B3352 10-1 Ratio		8 RPH 120 V. 50 CYC. B3353 30-1 Ratio		8 RPH 120 V. 50 CYC. B3354 60-1 Ratio		GEAR POSITION	TEETH	PITCH	PART NUMBER
CHART SPEED, INCHES PER HOUR															
FAST	SLOW	FAST	SLOW	FAST	SLOW	FAST	SLOW	FAST	SLOW	FAST	SLOW				
3/4	.075	3/4	.025	3/4	.0125	3/4	.075	3/4	.025	3/4	.0125	A B	12 48	64 64	A10402 A10342
1	.1	1	.033	1	.0166	1	.1	1	.033	1	.0166	A B	16 48	64 64	A10399 A10342
1 1/2	.15	1 1/2	.05	1 1/2	.025	1 1/2	.15	1/1/2	.05	1 1/2	.025	A C	12 24	64 64	A10402 A10342
2	.2	2	.066	2	.003	2	.2	2	.066	2	.003	A C	16 24	64 64	A10399 A10342
3	.3	3	.1	3	.05	3	.3	3	.1	3	.05	A B	48 48	64 64	A10398 A10342
4	.4	4	.133	4	.066	4	.4	4	.133	4	.066	A B	64 48	64 64	A10395 A10342
6	.6	6	.2	6	.1	6	.6	6	.2	6	.1	A C	48 24	64 64	A10398 A10342
8	.8	8	.266	8	.133	8	.8	8	.266	8	.133	A C	64 24	64 64	A10395 A10342

FIGURE 16D. TABLE OF MOTORS AND CHANGE GEARS FOR 2-SPEED CHART DRIVES ON STRIP CHART RECORDERS (ATT. TD84)

CHART DRIVE MOTORS		CHANGE GEARS			
8 RPM 120 V. 60 CYC. A13813 Double Torque	8 RPM 120 V. 50 CYC. A13682 Double Torque	GEAR POSITION	TEETH	PITCH	PART NUMBER
CHART SPEED					
INCHES	MIN.				
4	4	A B	64 48	64 64	A10395 A10342
6	6	A C	48 24	64 64	A10398 A10342
8	8	A C	64 24	64 64	A10395 A10342

FIGURE 17A. TABLE OF MOTORS AND CHANGE GEARS FOR FOUR-SPEED CHART DRIVES USING DOUBLE TORQUE MOTOR

CHART DRIVE MOTORS		CHANGE GEARS			
8 RPM 120 V. 60 CYC. A13629	8 RPM 120 V. 50 CYC. A13630	GEAR POSITION	TEETH	PITCH	PART NUMBER
CHART SPEED					
INCHES	MIN.				
3/4	3/4	A B	12 48	64 64	A10402 A10342
1	1	A B	16 48	64 64	A10399 A10342
1 1/2	1 1/2	A C	12 24	64 64	A10402 A10342
2	2	A C	16 24	64 64	A10399 A10342
3	3	A B	48 48	64 64	A10398 A10342

FIGURE 17B. TABLE OF MOTORS AND CHANGE GEARS FOR FOUR-SPEED CHART DRIVES

THE BRISTOL COMPANY
Waterbury, Connecticut, 06720, U.S.A.

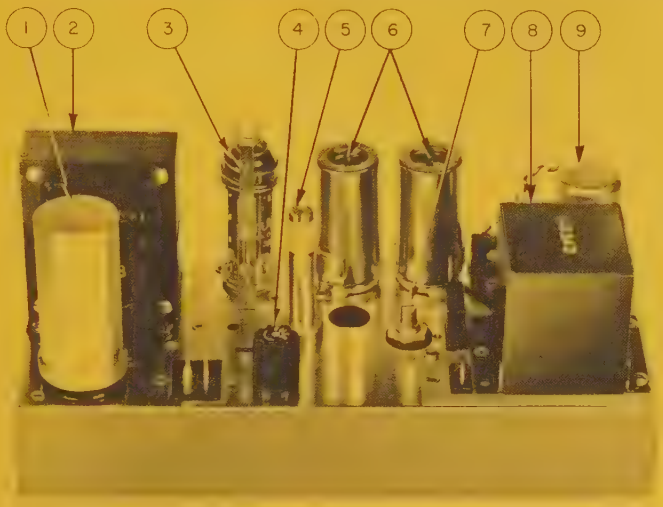
PARTS LIST
October 1964

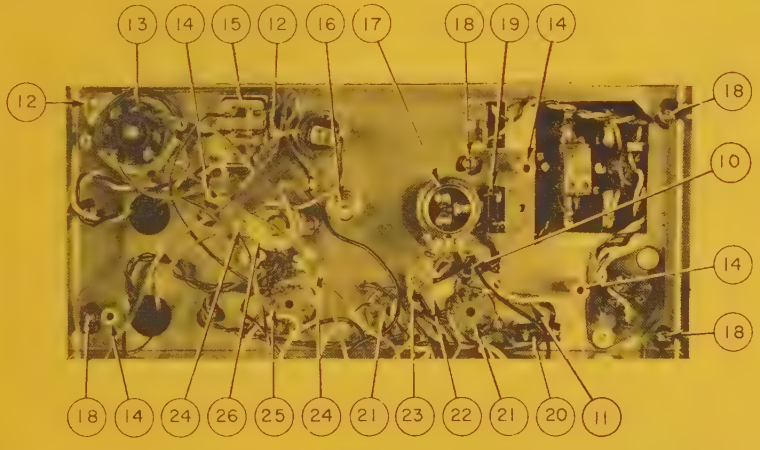
P12609

Replaces issue of 6/64

PARTS LIST FOR BRISTOL AMPLIFIERS

SERIES L10, L11, L12 AND L13





BE SURE TO STATE MODEL AND SERIAL NUMBER OF INSTRUMENT WHEN ORDERING PARTS

ITEM	PART NO.	DESCRIPTION
	C2366	Series "L10" Amplifier complete, 120 v. 60 cy. (does not include input transformer or Syncroverter switch)
	C2914	Series "L11" Amplifier complete, 120 V. 50 cy. (does not include input transformer or Syncroverter switch)
	C2915	Series "L12" Amplifier complete, 120 V. 60 cy. with auxiliary gain control. (does not include input transformer or Syncroverter switch)
	C2916	Series "L13" Amplifier complete, 120 V. 50 cy. with auxiliary gain control. (does not include input transformer or Syncroverter switch)
1	83974	Capacitor 10-10-10 mfd.
2	B2653	Power transformer
3	A10475	Tube 6BQ5
	A10464	Tube hold down
4	A9895	Fuse holder
	A10485	Fuse 1/8 amp.
5	A10474	Clamping screw
6	A9675	Tube 6EU7
	A2720	Tube shield
8		Input transformer, plug-in unit complete, (does not include Syncroverter switch)
	B3240	100 ohms
	B3241	1000 ohms
	B3242	10,000 ohms
	B3243	100,000 ohms
	B3244	1,000 ohms (high isolation)
	B3244-1	10,000 ohms (high isolation)
	B3244-2	100,000 ohms (high isolation)
9	C1415-2	Syncroverter switch
10	83981	Resistor - 4.7 meg. 1/2 watt ±10% tolerance
11	A8823	Resistor - 33 ohms, 3 watt ±5% tolerance
12	92359	Eyelet
13	71708	Tube socket
14	A10472	Post
15	A10462	Power plug
16	A10473	Threaded bushing
17	A10979	Gain control potentiometer
18	A13234	Insert
19	A12122	Socket
20	A9555	Socket
21	A10467	Tube socket, 9 pin (top mounting)
22	97631	Capacitor - .02 mfd. 1000 V. (ceramic) ±20% tolerance
23	97630	Capacitor -470 mmfd. 1000 V. (ceramic) ±10% tolerance
24	36342	Eyelet
25	A10468	Tube socket, 9 pin (bottom mounting)
26	A10470	Potentiometer
30	97619	Resistor - 10K ohms, 7 watts, ±5% tolerance
31	A10478	Resistor - 6.8K ohms, 1/2 watt, ±5% tolerance
32	97617	Resistor - 250 ohms, 3 watts, ±5% tolerance
33	A7051	Diode (1N2071)
34	97627	Capacitor - .25 mfd. 600 V. (paper) ±20% tolerance
35	A12785	Capacitor - 50 mfd. 50V. (electrolytic) +75% -10% tolerance
36	B2693	Printed circuit board assembly complete
	B2692	Printed circuit board only
37	A12996	Resistor - 2000 ohms, 3 watts, ±5% tolerance
38	90592	Capacitor - .0062 mfd. (mica) ±5% tolerance, used on type L10 and L12
	93960	Capacitor - .0075 mfd. used on type L11 and L13
39	97620	Resistor - 22K ohms, 10 watts ±5% tolerance
40	83980	Resistor - 1 meg. 1/2 watt ±10% tolerance
41	72226	Resistor - 10K ohms, 1/2 watt ±10% tolerance
42	A9880	Resistor - 3.3K ohms, 1/2 watt ±10% tolerance
43	A10476	Capacitor - 50 mfd. 15 volt (electrolytic) +150% -10% tolerance
44	A9881	Resistor - 220K ohms, 1/2 watt ±10% tolerance
45	97631	Capacitor - .02 mfd. 1000 V. (ceramic) ±20% tolerance
46	83979	Resistor - 470K ohms 1/2 watt ±10% tolerance
47	97685	Resistor - 300K ohms 1/2 watt ±2% tolerance
48	97624	Capacitor - 12 mfd. 250 volt (electrolytic) +150% -10% tolerance
50		Calibrating resistor
51	97684	Resistor - 240K ohms, 1/2 watt ±2% tolerance
52	89085	Resistor - 68K ohms, 1 watt ±10% tolerance
53		Calibration resistor
54	97682	Resistor - 56K ohms, 1 watt ±10% tolerance
55	97626	Capacitor - .022 mfd. 600 V. (paper) ±10% tolerance
56	A9591	Capacitor - 1 mfd. 6 volt (electrolytic) +150% -10% tolerance
57	97622	Resistor - 680K ohms, 1 watt ±5% tolerance

*ADDITIONAL TERMINALS AS REQ'D. PER ATTACHMENT DRAWING.

P3 PIN COLOR CODE
1. RED
2. BLUE
3. GRAY
4.
5. BLACK
6. WHITE

CHASSIS

REAR OF CASE

CHART DRIVE MOTOR

BALANCING MOTOR

PEN LIFTER (OPTIONAL)

"R" AS REQ'D.

P3

LOCATOR PIN

BLUE
RED
WHITE
BLACK
BLACK
WHITE

GRAY
BLACK-WH.
WHITE
BLACK

INSTRUMENT ON-OFF SWITCH

WHITE
BLACK

TB3

BLACK-WH. — 4 — TO RUN VOLTAGE
GRAY — GND — 1
WHITE — L2 — 3
BLACK — L1 — 2

L3 | M2 | M1 | L2 | L1 | GND | TB1

REMOTE | OFF | LOCAL

RED
WHITE
BLUE
BLACK
GRAY
SHIELD
SHIELD

BRIDGE SUPPLY
L1
L2
GND

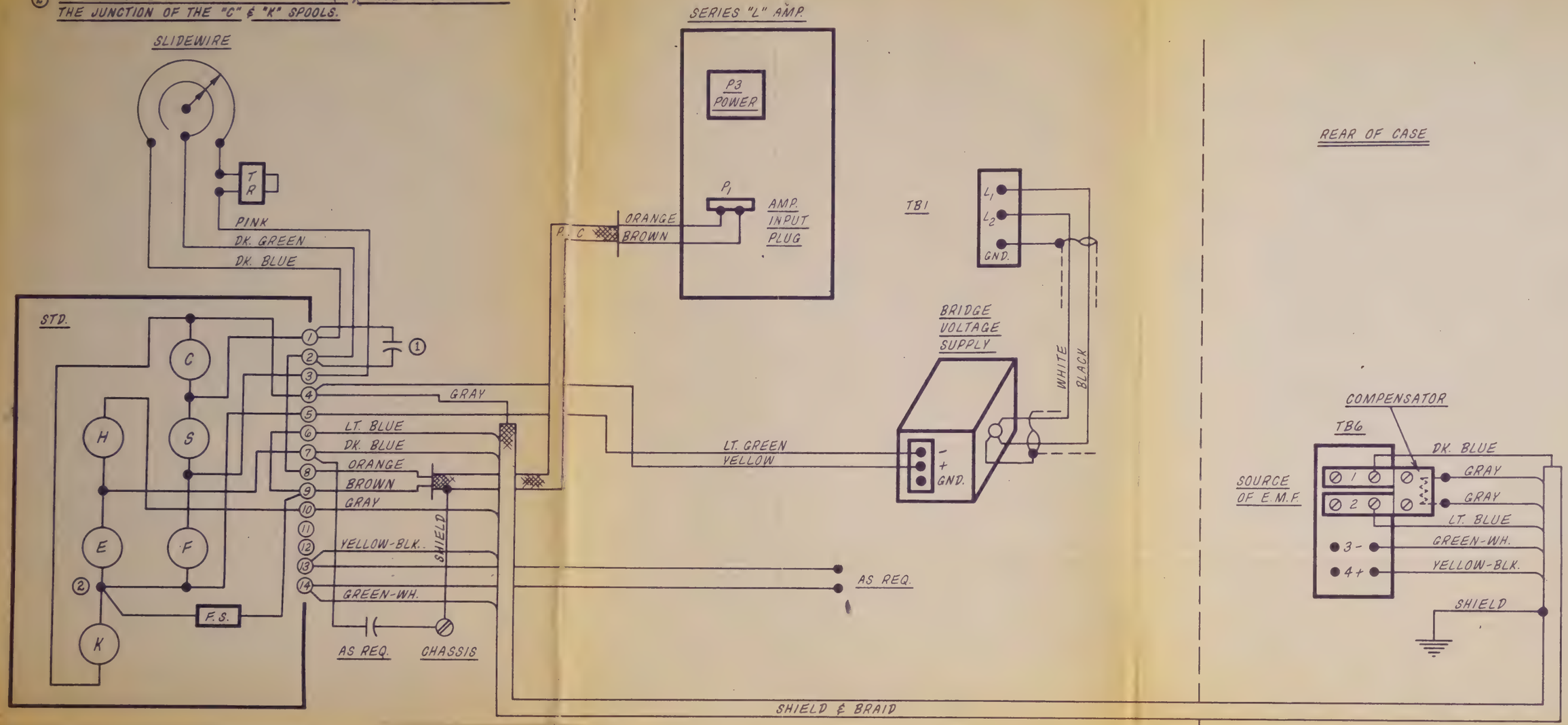
REVISIONS			

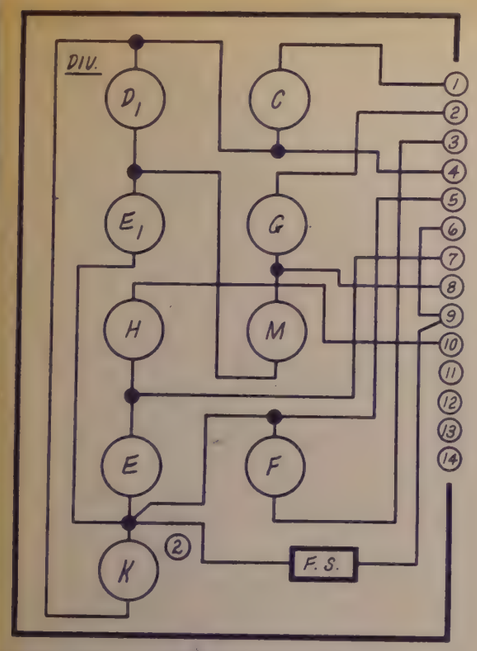
POWER WIRING DIAGRAM FOR 760-765 DYNAMASTER POTENTIOMETER RECORDER.

THE BRISTOL COMPANY
WATERBURY, CONN. U.S.A.

DRAWN RAF	DATE 3-1-66
TRACED	CHECKED JK / APPROVED
SCALE	FILE DR. 221
NO. 022375	

NOTE:
① PT. #A8803 ANTI-BOUNCE CAP. USED ON 1 SEC. D.C. ONLY.
② IF DOWNSCALE FAILSAFE ACTION IS REQ'D., MOVE THIS WIRE TO THE JUNCTION OF THE "C" & "K" SPOOLS.





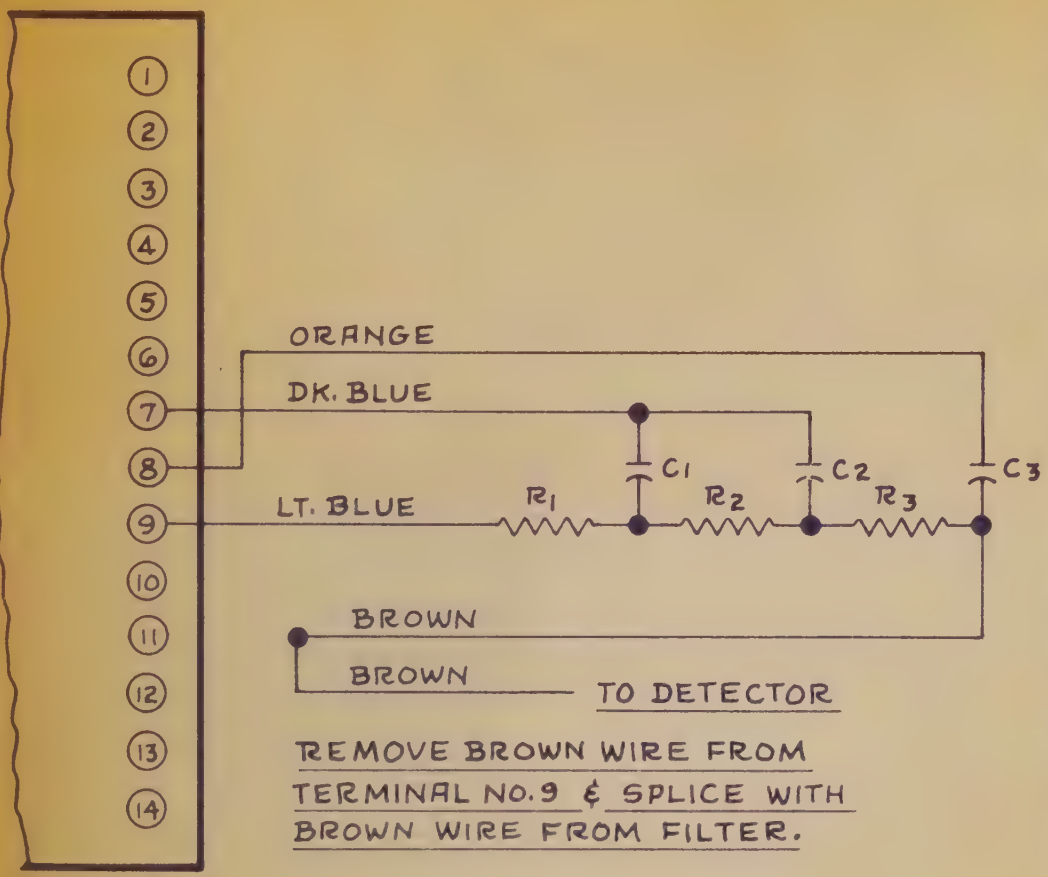
PYROMETER
MEASURING CIRCUIT WIRING DIAGRAM
FOR 760-765 DYNAMASTER POTENTIOMETER RECORDER.

1-21-65	
2-3-65	

THE BRISTOL COMPANY
WATERBURY, CONN., U S A

DRAWN B.E.H. APPROVED TRACED
CHECKED J.F. Dodge DATE 11-20-64 SCALE
DRAWER No. 221
SHEET No. 021171

TERMINAL BLOCK



REMOVE BROWN WIRE FROM TERMINAL NO. 9 & SPLICE WITH BROWN WIRE FROM FILTER.

AUX. WIRING DIAGRAM FOR HEAVY DUTY FILTER FOR SINGLE & MULTIPLE POINT 760-765 DYNAMASTER POT. RECORDER.

THE BRISTOL COMPANY
WATERBURY, CONN. U.S.A.

DRAWN ARE	DATE 12-2-64
TRACED	CHECKED J. T. Gooley
SCALE	FILE DR. 21
NO. 021180	APPROVED

REVISIONS

NO. 021180

K&E PHOENIX ® 72797 TRACING CLOTH

Instruction W-18220
Issued April 1954

HOW TO ORDER PARTS AND SUPPLIES FOR BRISTOL PRODUCTS

In all correspondence concerning any product of the Bristol Company, always give the model and serial number of the product concerned. Send your purchase order or quotation request to the nearest Bristol Company Branch Office (see the back of this sheet for addresses).

REPLACEMENT PARTS

When ordering replacement parts look up the part name and number in the parts list provided with the instructions that came with your product. When you cannot find a part number, give an accurate description of the part. If you have mislaid your parts list write for a new one giving the model and serial number of the product.

CHARTS

In ordering charts for recorders, give the chart number (printed on the chart and also on the instrument name plate).

Avoid inconvenient emergency orders by keeping a six months supply of charts on hand for each of your recorders.

THERMOCOUPLES

Pyrometer thermocouples should be ordered from Bulletin P-1238. Be sure to specify the catalog number and the length. If you do not have Bulletin P-1238, write for one.

Pyrometer users should always have a supply of spare thermocouples.

SAMPLE PURCHASE ORDER:

QUANTITY REQUIRED	DESCRIPTION	PART, CHART OR CATALOG NUMBER
1000	Charts, 0° to 1500°F	5342
5	7-day electric chart drive for 115 volts, 60 cycles	86226
4	Pen arms marked CD	49703
1	Knurled plastic knob on outside of case, ½" diameter, 3/16" hole for moving set-point index	none given
1	1 oz. bottle red ink	6883
	The above parts are for a Bristol thermometer controller Model 1T1X500B-2, serial number 767211.	
4	IC thermocouples, length 30"	3BS14N2
	The above thermocouples are for a Bristol pyrometer Model 487-L, serial number 202953	

THE BRISTOL COMPANY

A Subsidiary of American Chain & Cable Company, Inc.

Waterbury, Conn. 06720

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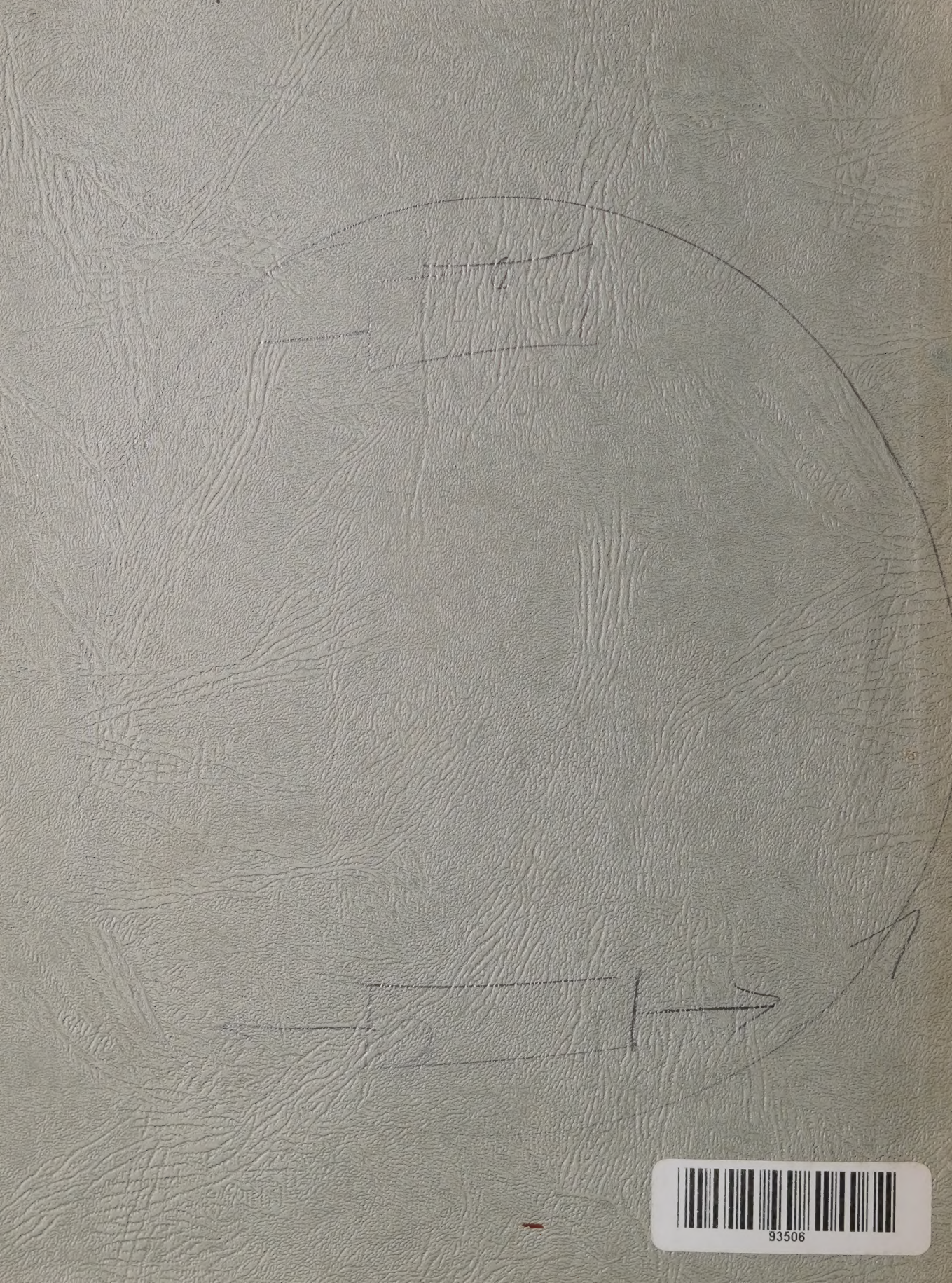
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